B. Tech – II Year I Semester

S.No	Category	Title	L	T	P	Credits
1	BS	Numerical Techniques and Statistical Methods	3	0	0	3
2	HSMC	Universal human values – understanding harmony and Ethical human conduct	2	1	0	3
3	Engineering Science	Thermodynamics & Thermal Engineering	3	0	0	3
4	Professional Core	Fluid Mechanics & Hydraulic Machines	3	0	0	3
5	Professional Core	Components of Automotive Chassis	3	0	0	3
6	Professional Core	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
7	Professional Core	Automotive Chassis Lab	0	0	3	1.5
8	Skill Enhancement Course	Computer Aided drafting and Automobile Assembly Drawing	0	1	2	2
9	Audit Course	Environmental Science	2	0	0	-
Total			**16**	**2**	**8**	**20**

B. Tech – II Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Management Course- I	Product Life Cycle Management	2	0	0	2
2	Engineering Science/Basic Science	Mechanics of Solids	3	0	0	3
3	Professional Core	Automobile Engines	3	0	0	3
4	Professional Core	Automobile Electrical and Electronics	3	0	0	3
5	Professional Core	Metallurgy and Material Science	3	0	0	3
6	Professional Core	Automobile Engines & Fuels Lab	0	0	3	1.5
7	Professional Core	Automobile Electrical and Electronics Lab	0	0	3	1.5
8	Skill Enhancement Course	Machine Tools and Metrology Lab	0	1	2	2
9	Engineering Science	Design Thinking & Innovation	1	0	2	2
Total			**15**	**1**	**10**	**21**
Mandatory Community Service Project Internship of 08 weeks duration during Summer Vacation						

L	T	P	C
3	0	0	3

II Year - I Semester

NUMERICAL TECHNIQUES AND STATISTICAL METHODS

Course Objectives:

- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

UNIT – I: Iterative Methods: **(9 Hrs)**

Introduction – Solutions of algebraic and transcendental equations: Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations)

Interpolation: Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula

UNIT – II: Numerical integration, Solution of ordinary differential equations with initial conditions: **(9 Hrs)**

Trapezoidal rule– Simpson's $1/3^{rd}$ and $3/8^{th}$ rule– Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method –Runge-Kutta method (second and fourth order) – Milne's Predictor and Corrector Method.

UNIT – III: Probability and Distributions: **(9 Hrs)**

Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory: **(9 Hrs)**

Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) –Point and Interval estimations – Maximum error of estimate – Central limit theorem (without proof) – Estimation using t, χ^2 and F-distributions.

UNIT – V: Tests of Hypothesis: **(9 Hrs)**

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance– One tail and two-tail tests – Test of significance for large samplesand Small Samples: Single and difference means – Single and two proportions – Student's t- test, F-test, χ^2 -test.

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. Miller and Freund's, Probability and Statistics for Engineers,7/e, Pearson, 2008.

Reference Books:

1. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineering and Science,Tata Mc. Graw Hill Education.
2. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
3. Lawrence Turyn,Advanced Engineering Mathematics, CRC Press.
4. S. C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
5. Shron L. Myers, Keying Ye, Ronald E Walpole, Probability and Statistics Engineers and the Scientists,8th Edition, Pearson 2007.
6. Jay l. Devore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.

Course Outcomes:

COs	Statements	Blooms Level
CO1	Evaluate the approximate roots of polynomial and transcendental equations by different algorithms. Apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals	L3
CO2	Apply numerical integral techniques to different Engineering problems. Apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations	L3
CO3	Apply discrete and continuous probability distributions	L3
CO4	Design the components of a classical hypothesis test	L6
CO5	Infer the statistical inferential methods based on small and large sampling tests	L4

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

R23 AUTOMOBILE ENGINEERING COURSE STRUCTURE & SYLLABUS

II B. Tech I Semester

L	T	P	C
2	1	0	3

UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT

Course Objectives:

- To help the students appreciate the essential complementary between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course Outcomes:

- Define the terms like Natural Acceptance, Happiness and Prosperity (L1, L2)
- Identify one's self, and one's surroundings (family, society nature) (L1, L2)
- Apply what they have learnt to their own self in different day-to-day settings in real life (L3)
- Relate human values with human relationship and human society. (L4)
- Justify the need for universal human values and harmonious existence (L5)
- Develop as socially and ecologically responsible engineers (L3, L6)

Course Topics

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

UNIT I Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session PS1 Sharing about Oneself
Lecture 3: self-exploration as the Process for Value Education
Lecture4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2 Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT II Harmony in the Human Being (6 lectures and 3 tutorials for practice session)
Lecture 7: Understanding Human being as the Co-existence of the self and the body.
Lecture 8: Distinguishing between the Needs of the self and the body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.
Lecture 9: The body as an Instrument of the self
Lecture 10: Understanding Harmony in the self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self
Lecture 11: Harmony of the self with the body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT III Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)
Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

UNIT IV Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)
Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

UNIT V Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)
Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Practice Sessions for UNIT I – Introduction to Value Education

PS1 Sharing about Oneself
PS2 Exploring Human Consciousness
PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being
PS4 Exploring the difference of Needs of self and body
PS5 Exploring Sources of Imagination in the self
PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society
PS7 Exploring the Feeling of Trust
PS8 Exploring the Feeling of Respect
PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)
PS10 Exploring the Four Orders of Nature
PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12 Exploring Ethical Human Conduct
PS13 Exploring Humanistic Models in Education
PS14 Exploring Steps of Transition towards Universal Human Order

READINGS:
Textbook and Teachers Manual
a. The Textbook
R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
b. The Teacher's Manual
R R Gaur, R Asthana, G P Bagaria,*Teachers' Manual for A Foundation Course in Human Values and Professional Ethics,* 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books
1. *JeevanVidya: EkParichaya,* A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. *Human Values,* A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book).
4. *The Story of My Experiments with Truth* - by Mohandas Karamchand Gandhi
5. *Small is Beautiful* - E. F Schumacher.
6. *Slow is Beautiful* - Cecile Andrews
7. *Economy of Permanence* - J C Kumarappa
8. *Bharat Mein Angreji Raj* – PanditSunderlal
9. *Rediscovering India* - by Dharampal
10. *Hind Swaraj or Indian Home Rule* - by Mohandas K. Gandhi
11. *India Wins Freedom* - Maulana Abdul Kalam Azad
12. *Vivekananda* - Romain Rolland (English)
13. *Gandhi* - Romain Rolland (English)

Mode of Conduct:
Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.
Tutorial hours are to be used for practice sessions.
While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up ”ordinary” situations rather than” extra-ordinary” situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.
It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.
Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

Online Resources:

1. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf
3. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf
4. https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%2023.pdf
5. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
6. https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf
7. https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf
8. https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

L	T	P	C
3	0	0	3

II B. Tech I Semester

THERMODYNAMICS & THERMAL ENGINEERING

Course Objectives:

1. To impart knowledge of basic principles of thermodynamics via real world engineering examples.
2. To analyse and evaluate cardinal air standard cycles.
3. To analyse and evaluate cardinal Steam power cycles.
4. Summarize the governing concepts of Refrigeration and Air conditioning.
5. To introduce various modes of heat and mass transfer, related to real time scenarios of thermodynamics applied in engineering practice

UNIT – I: BASIC THERMODYNAMICS (10 Hrs)

Systems, closed, open and isolated. Property, state, path and process, quasi-static process, Zeroth low, First law. Steady flow energy equation. Engineering Applications of Steady flow energy equation Heat and work transfer in flow and non-flow processes. Second law, Kelvin-Planck statement – Clausius statement - Concept of Entropy, Clausius inequality, Entropy change in nonflow processes. Availability and Un Availability. Properties of gases and vapours

UNIT – IIAIR STANDARD CYCLES AND COMPRESSORS (10 Hrs)

Cycle, Carnot cycle, Otto, Diesel, Dual combustion and Brayton cycles. Air standard efficiency. Mean effective pressure. Comparison of cycles, Efficiency versus compression ratio, For the same compression ratio and the same heat input.

Compressors, Classifications of compressors, Single stage and multi stage, Effect of intercooler in multi stage compressor, Perfect and imperfect intercooler, work done by the compressor, Reciprocating, Rotary, Axial, Vane compressors.

UNIT – III: STEAM (8 Hrs)

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface Properties of steam, Dryness fraction, Quality of steam by steam tables and Mollier chart – Rankine cycle, Work done, Steam rate – Steam Nozzles, Types of nozzles, Friction in nozzles.

UNIT – IV: REFRIGERATION AND AIR-CONDITIONING (8 Hrs)

Principles of refrigeration, Vapour compression – Types of VCR system with respect to condition of vapour, Problems, Vapour absorption types, comparison - Co-efficient of performance (COP), Properties of refrigerants – Basic Principle, Summer, winter and Year round Air conditioning.

UNIT – V: HEAT AND MASS TRANSFER **(10 Hrs)**

Heat Transfer: Modes of heat transfer, Heat conduction in parallel, radial and composite wall – Heat conduction through hollow and composite cylinders, spheres. Basics of Convective heat transfer. Fundamentals of Radiative heat transfer – Flow through heat-exchangers, Logarithmic Mean Temperature Difference (LMTD) for parallel flow and counter flow heat exchangers.

Mass Transfer: Concepts of mass transfer, diffusion & convective mass transfer, Fick's Law of diffusion, Significance of non-dimensional numbers.

Text Books:

1. Chattopadhyay. P Engineering Thermodynamics", oxford University Press, New Delhi, 2010.
2. Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2007.
3. Rathakrishnan E., "Fundamentals of Engineering Thermodynamics" Prentice-Hall India, 2005.

Reference Books:

1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Holman.J.P., "Thermodynamics", 3rd Ed. McGraw-Hill, 2007.
3. Mathur& Sharma Steam Tables, Jain Publishers, New Delhi.
4. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004.
5. Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	demonstrate understanding of the nature of the thermodynamic processes for pure substances of ideal gases.	L2
CO2	interpret First Law of Thermodynamics and its application to systems and control volumes.	L2
CO3	solve any flow specific problem in an engineering approach based on basic concepts and logic sequences.	L5
CO4	compare and contrast between various types of refrigeration cycles	L2
CO5	Get exposed to the basics and modes of heat transfer	L1

L	T	P	C
3	0	0	3

II B. Tech – I Semester

FLUID MECHANICS & HYDRAULIC MACHINES

Course Objectives: The students completing this course are expected to understand the properties of fluids, its kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations. Further, the student shall be able to understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines**.**

UNIT – I: (10 Hrs)

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of metacenter height. Stability analysis and applications.

UNIT – II: (10 Hrs)

Fluid kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for irrotational flow, flow net, source and sink, doublet and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications, force on pipe bend.

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line.

UNIT – III: (8 Hrs)

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations, Method of repeating variables and Buckingham Pi Theorem.

UNIT – IV: (8 Hrs)

Basics of turbo machinery: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – draft tube- theory- functions and efficiency.

UNIT – V: **(10 Hrs)**

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and oscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH.

Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

Text Books:

1. Fluid Mechanics- Fundementals and Applications by Y.A. Cengel, J.M.Cimbala, 6thEdn, McGrawHill
2. Fluid Mechanics - Dixon, 7th Edn, Elesvier

Reference Books:

1. Hydraulics, fluid mechanics and Hydraulic machinery- Modi and Seth
2. Fluid Mechanics and Hydraulic Machines - RK Bansal- Laxmi Publications (P)Ltd.
3. Fluid Mechanics and Hydraulic Machines -Rajput
4. Fluid Mechanics and Fluid Power Engineering - D.S. Kumar, Kotaria&Sons.
5. Fluid Mechanics and Machinery - D. Rama Durgaiah, New Age International.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand the basic concepts of fluid properties.	L2
CO2	Demonstrate the concepts of mechanics of fluids in static and dynamic conditions.	L2
CO3	Illustrate the Boundary layer theory, flow separation and dimensional analysis.	L2
CO4	Calculate the hydrodynamic forces of jet on vanes in different positions.	L3
CO5	Understand the working Principles and performance evaluation of hydraulic pump and turbines.	L2

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R23 AUTOMOBILE ENGINEERING COURSE STRUCTURE & SYLLABUS

L	T	P	C
3	0	0	3

II B. Tech – I Semester

COMPONENTS OF AUTOMOTIVE CHASSIS

COURSE OBJECTIVES:

i. To understand the basic knowledge about various vehicle frames, front axles, steering systems and understand the conditions for true rolling motion of wheels during steering.
ii. To recognize the construction and working principle of drive line, final drive and differential systems
iii. To review the knowledge about the constructional feature of rear axle, wheels and tyres.
iv. To evaluate the working principles of both conventional and independent suspension system.
v. To demonstrate working principle of braking system used in automobile.

UNIT – I: INTRODUCTION, FRAME, CLUTCHES & GEAR BOX (10 Hrs)

Types of Chassis layout, with reference to Power Plant location and drive, various types of frames, Loads acting on vehicle frame, Constructional details and materials for frames, Testing of frames. Importance of Clutch, types and Applications. Requirement of Gear Box, Manual types of Gear Boxes including Synchromesh and its Applications

UNIT – II:PROPELLER SHAFT AND FINAL DRIVE (10 Hrs)

Effect of Driving Thrust, torque reactions and side thrust, Hotchkiss drive, torque tube drive, radius rods and stabilizers, Propeller Shaft, Universal Joints, Constant Velocity Universal Joints, Front Wheel drive, Final drive, different types, Double reduction and twin speed final drives, Multi–axled vehicles, Differential principle and types, Differential housings, limited speed differential, Differential locks.

UNIT – III: AXLES AND TYRES (8 Hrs)

Construction and Design of Drive Axles, Types of Loads acting on drive axles, Full – Floating, Three– Quarter Floating and Semi–Floating Axles, Axle Housings and Types – Lift axle, Dead axle, Types and Constructional Details of Different Types of Wheels and Rims, Different Types of Tyres and their constructional details.

UNIT – IV: STEERING & SUSPENSION SYSTEM (10 Hrs)

Steering System: Types of Front Axles and Stub Axles, Front Wheel Geometry, Condition for True Rolling Motion of Wheels during Steering, Ackerman's and Davis Steering Mechanisms, Steering Error Curve, Steering Linkages, Different Types of Steering Gears, Slip Angle,Over–Steer and Under–Steer, Reversible and Irreversible Steering, EPAS.

Suspension System: Types of Suspension Springs, Constructional details and characteristics of Single Leaf, Multi–Leaf, Coil, Torsion bar, Rubber, Pneumatic and Hydro – elastic Suspension Spring Systems, Independent Suspension System, Shock Absorbers, Types and Constructional details.

UNIT – V: BRAKING SYSTEM **(8 Hrs)**

Theory of Automobile Braking, Stopping Distance Time and Braking Efficiency, Effect of Weight Transfer during Braking, Theory of Drum Brakes, Loading and Trailing Shoes, Braking Torque, Constructional Details of Drum Brake and its Activators, Disc Brake Theory, Types and Construction, Hydraulic Braking System, Mechanical Braking System, Pneumatic Braking System, Power–Assisted Braking System, Anti–Lock Braking System, Constructional Details.

Text Books:

1. Kirpal Singh, Vol- I, Automobile Engineering, Standard Publisher, New Delhi ,2017
2. K.K.Ramalingam, "Automobile Engineering", scitech publication (India),2011.
3. R.K. Rajput, A Text–Book of Automobile Engineering, Laxmi Publications Private Limited,2015

Reference Books:

1. Heinz Hazler, Modern Vehicle Technology, Butterworth, London,2005.
2. HeldtP.M., Automotive Chassis, Chilton Co., New York,1990
3. Newton Steeds and Garret, Motor Vehicles, 13th Edition, Butterworth, London, 2005.
4. N.K. Giri, Automotive Mechanics, Kanna Publishers,2007
5. William. H. Crows – Work shop Manuel –2005

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Identify the different types of frame and chassis used in Automotive.	L2
CO2	Relate different types of drive lines and drives used in Automotive.	L2
CO3	Acquire knowledge about different types of front axle and rear axles used in motor vehicles.	L2
CO4	Examine the working principle of conventional and independent suspension systems.	L4
CO5	Apply knowledge on working principles of brake and its subsystems.	L3

L	T	P	C
0	0	3	1.5

II B. Tech – I Semester

FLUID MECHANICS & HYDRAULIC MACHINES LAB

COURSE OBJECTIVES:

To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

LIST OF EXPERIMENTS:

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orifice meter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flowmeter.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand calibration of flow measuring devices.	L2
CO2	Evaluate the losses in pipe flows.	L5
CO3	Apply the practical aspects of Bernoulli's principle	L3
CO4	Analyse the characteristics of different types of hydraulic turbines.	L4
CO5	Analyse the characteristics of different types of hydraulic pumps	L4

II B. Tech – I Semester

L	T	P	C
0	0	3	1.5

AUTOMOTIVE CHASSIS LAB

COURSE OBJECTIVES:

i. To assemble and disassemble the parts of an IC engine.
ii. To identify the various component of an IC engine.
iii. To identify the various components in transmission systems of an automobile.
iv. To assemble and disassemble the various components of transmission system.
v. To study all the functions of automobile components

LIST OF EXPERIMENTS:

1. To study constructional and working principle of clutch.
2. Assembly & Disassembly of Gear Box.
3. Assembly & Disassembly of Transfer case.
4. Assembly & Disassembly of Differential & rear axle.
5. Assembly & Disassembly of Stub Axle Assembly.
6. To assemble and disassemble Front axle.
7. To Study different chassis layouts
8. To Study braking system
9. To Study Steering system.
10. To Study Suspension system
11. To study Continuous Variable Transmission System
12. Study of different types of Wheels & Tyres

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand working of braking, steering, clutch, transmission, Suspension systems.	L2
CO2	Differentiate various subsystems of two, three & Four wheeler vehicles	L2
CO3	Develop skills in Dismantling and assembling of chassis components.	L3

II B. Tech I Semester

L	T	P	C
0	1	2	2

COMPUTER AIDED DRAFTING AND AUTOMOBILE ASSEMBLY DRAWING

COURSE OBJECTIVES:

i. Introduce conventional representations of material and machine components.
ii. Train to use software for 2D and 3D modeling.
iii. Familiarize with thread profiles, riveted, welded and key joints.
iv. Teach solid modeling of machine parts and their sections.
v. Explain creation of 2D and 3D assembly drawings.
vi. Familiarize with limits, fits and tolerances in mating components.

The following contents are to be done by any 2D software package

Conventional representation of materials and components:
Detachable joints: Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.
Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.
Welded joints: Lap joint and T joint with fillet, butt joint with conventions.
Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.
Couplings: rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldhams' coupling.
The following contents to be done by any 3D software package Sectional views:
Creating solid models of complex machine parts and create sectional views.
Assembly drawings:(Any six of the following using solid model software)
Connecting Rod, Multi-plate Friction Clutch, Automobile Gear Box, Stub Axle, Tandem Master Cylinder, Fuel Injector, Piston, Radial Engine Sub Assembly.
Manufacturing drawing:
Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Textbooks:

1. K.L.Narayana, P.Kannaiah and K.Venkat Reddy, Production Drawing, New Age International Publishers, 3/e, 2014
2. Software tools/packages- Auto CAD, Solid works or equivalent.

Reference Books:

1. Cecil Jensen, Jay Helsel and Donald D.Voisinet, Computer Aided Engineering Drawing, Tata Mcgraw-Hill, NY, 2000.
2. James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3. N.D.Bhatt, Machine Drawing, Charotar, 50/e, 2014

Online Learning Resources:

https://eeedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf,

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Interpret and analyse the national and international standards of various machine components.	L4
CO2	Apply and illustrate various machine elements through computer aided drawings.	L3
CO3	Apply limits and tolerances to assemblies and interpret the appropriate fits.	L3
CO4	Recognise the machining surface finish parameters through appropriate symbols.	L2

II Year I Semester

L	T	P	C
2	0	0	-

ENVIRONMENTAL SCIENCE

Course Objectives:

- To make the students to get awareness on environment
- To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day-to-day activities of human life
- To save earth from the inventions by the engineers.

UNIT – I

Multidisciplinary Nature of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

UNIT – II

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and Its Conservation : Introduction and Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III

Environmental Pollution: Definition, Cause, effects and control measures of:

a. Air Pollution.

b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V

Human Population And The Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Textbooks:

1. Erach Bharucha,Text book of Environmental Studies for Undergraduate Courses,Universities Press (India) Private Limited, 2019.
2. Palaniswamy, Environmental Studies, 2/e, Pearson education, 2014.
3. S.Azeem Unnisa, Environmental Studies, Academic Publishing Company, 2021.
4. K.Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, SciTech Publications (India), Pvt. Ltd, 2010.

Reference Books:

1. Deeksha Dave and E.Sai Baba Reddy, Textbook of Environmental Science, 2/e, Cengage Publications, 2012.
2. M.Anji Reddy, “Textbook of Environmental Sciences and Technology”, BS Publication, 2014.
3. J.P. Sharma, Comprehensive Environmental studies, Laxmi publications, 2006.

4. J. Glynn Henry and Gary W. Heinke, Environmental Sciences and Engineering, Prentice Hall of India Private limited, 1988.
5. G.R. Chatwal, A Text Book of Environmental Studies, Himalaya Publishing House, 2018.
6. Gilbert M. Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, 1/e, Prentice Hall of India Private limited, 1991.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc23_hs155/preview
- https://www.edx.org/learn/environmental-science/rice-university-ap-r-environmental-science-part-3-pollution-and-resources?index=product&objectID=course-3a6da9f2-d84c-4773-8388-1b2f8f6a75f2&webview=false&campaign=AP%C2%AE+Environmental+Science++Part+3%3A+Pollution+and+Resources&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fenvironmental-science
- http://ecoursesonline.iasri.res.in/Courses/Environmental%20Science-I/Data%20Files/pdf/lec07.pdf
- https://www.youtube.com/watch?v=5QxxaVfgQ3k

Course Outcomes:

COs	Statements	Blooms Level
CO1	Grasp multi disciplinary nature of environmental studies and various renewable and non-renewable resources.	L2
CO2	Understand flow and bio-geo- chemical cycles and ecological pyramids.	L2
CO3	Understand various causes of pollution and solid waste management and related preventive measures.	L2
CO4	Understand the rainwater harvesting, watershed management, ozone layer depletion and waste land reclamation.	L2
CO5	Illustrate the causes of population explosion, value education and welfare programmes.	L3

II B. Tech – II Semester

L	T	P	C
2	0	0	2

PRODUCT LIFE CYCLE MANAGEMENT

Course objectives: This course enables students to

1. Familiarize with various strategies of PLM
2. Understand the concept of product design and simulation.
3. Develop New product development ,product structure and supporting systems
4. Interpret the technology forecasting and product innovation and development in business processes.
5. Understand product building and Product Configuration.

UNIT-I: PLM AND PDM **(5 Hrs)**

Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.

UNIT-II: PRODUCT DESIGN **(5 Hrs)**

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product.

UNIT-III: PRODUCT DEVELOPMENT **(5 Hrs)**

New Product Development, Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.

UNIT-IV: TECHNOLOGY FORECASTING **(6 Hrs)**

Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.

UNIT-V: PRODUCT BUILDING AND STRUCTURES **(5 Hrs)**

Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.

Text Books:

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

Reference Books:

1. Saaksvuori Antti / ImmonenAnselmie, product Life Cycle Management Springer, Dreamtech, 3-540-25731-4
2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Explain the various strategies of PLM and Product Data Management	L2
CO2	Describe decomposition of product design and model simulation	L2
CO3	Apply the concept of New Product Development and its structuring.	L3
CO4	Analyze the technological forecasting and the tools in the innovation.	L4
CO5	Apply the virtual product development and model analysis	L3

II B. Tech – II Semester

L	T	P	C
3	0	0	3

MECHANICS OF SOLIDS

COURSE OBJECTIVE: The students completing this course are expected to understand the basic terms like stress, strain, poisson`s ratio…etc and different stresses and deflections induced in beams, thin cylinders, thick cylinders, and columns. Further, the student shall be able to understand the shear stresses due to torsion in circular shafts.

UNIT-I **(10 Hrs)**

SIMPLE STRESSES & STRAINS: Elasticity and plasticity – Types of stresses & strains– Hooke's law– stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses

Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT – II **(10 Hrs)**

Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads. Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT – III **(8 Hrs)**

FLEXURAL STRESSES: Theory of simple bending – Assumptions – Derivation of bending equation: M/ I = f/y = E/R Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

UNIT-IV **(10 Hrs)**

DEFLECTION OF BEAMS: Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, U.D.L uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams, Staticallyindeterminate Beams and solution methods.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel

UNIT – V **(8 Hrs)**

THIN AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders – Riveted boiler shells – Thin spherical shells. Wire wound thin cylinders. Lame's equation – cylinders subjected to inside & outside pressures –compound cylinders.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula,

TEXT BOOKS:

1. Strength of materials /GH Ryder/ Mc Millan publishers IndiaLtd.
2. Strength of materials by B.C. Punmia-lakshmi publications pvt.Ltd, New Delhi.

REFERENCE BOOKS:

1. Mechanics of Materials by Gere &Timeshenko
2. Strength of Materials -By Jindal, UmeshPublications.
3. Strength of Materials by S.Timshenko- D. VAN NOSTRAND Company-PHIPublishers
4. Strength of Materials by Andrew Pytel and Ferdinond L. Singer Longman-HarpercollinsCollege Division
5. Solid Mechanics, byPopov-
6. Mechanics of Materials/Gere and Timoshenko, CBS Publishers

Course Outcomes: On the completion of the course the student will able to

CO's	Statements	Bloom's Level
CO1	Model &Analyze the behavior of basic structural members subjected to various loading and support conditions based on principles of equilibrium.	L4
CO2	Understand the apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.	L3
CO3	Students will learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams.	L4
CO4	Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior	L2
CO5	Design and analysis of Industrial components like pressure vessels.	L6

II B. Tech – II Semester

L	T	P	C
3	0	0	3

AUTOMOBILE ENGINES

COURSE OBJECTIVES:

1. To impart knowledge on basics of automotive SI and CI engines consisting of types, construction and working.
2. To Understand the actual engine working principle and its thermochemistry of fuel-air mixtures.
3. To learn the properties of gasoline and diesel fuel and combustion process involved in diesel engines.
4. To solve basic design problems of various operating parameters of the engines.
5. To analyze the performance and pollution characteristics of SAI and CI engine and learn modern developments in IC engine

UNIT-I: **(10 Hrs)**

ACTUAL CYCLES AND ENGINE CONSTRUCTION:

Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blow down-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines; Constructional Details of Four Stroke SI and CI Engines, Working Principle, Actual Indicator Diagram, Two Stroke Engine Construction and Operation, Comparison of Four Stroke and Two Stroke Engine Operation, Firing Order and Its Significance. Basics of Lubrication and Cooling systems, Introduction to Supercharging and turbocharging.

UNIT-II: **(8 Hrs)**

SI ENGINE FUELING & COMBUSTION

Fuel Systems:Multi point Injection system- Gasoline Direct Injection – GDI Pumps and Fuel Injectors - Pre-mixed charge combustion, Thermodynamic Analysis of Combustion, Cycle-to-Cycle Combustion variations and Knocking Combustion

UNIT-III: **(10 Hrs)**

CI ENGINE FUELING & COMBUSTION

Fuel Injection and Spray Structure: Fuel Atomization and Droplet size distribution, Sauter Mean Diameter, Spray Penetration. Fuel Injection Pumps, Injector. Types of Combustion Chambers, Diesel Combustion Process Characterization: Ignition Delay, Effect of Engine and Operational Parameters on Delay, Pre-mixed Combustion, Mixing Controlled Combustion. Thermodynamic Analysis. Multi Pulse Injections, Dual fuel technologies - Introduction to Low Temperature Combustion - Homogeneous Charge Compression Ignition(HCCI), Fuel Stratified Charge combustion/ Reactivity Controlled Compression Ignition (RCCI) Technologies, Pre-mixed Charge Compression (PCCI).

UNIT-IV: **(10 Hrs)**

FORMATION OF ENGINE EMISSIONS & CONTROL TECHNOLOGIES (SI & CI)

Emission Effects on Health & Environment: Sources of Engine emissions: Formation of CO, NO, UBHC, Soot and Particulate Matter. Diesel NOx-Particulate Trade off: Effect of SI Design and operating variables: Effect of Diesel Engine Design and operating Variables. SI Engine Emission Control Technology: CI Engine Emission Control Technology: Exhaust Gas Recirculation, Diesel Particulate Filter, Selective Catalyst Reduction and Diesel Oxidation Converter, Lean NOx Trap(LNT).

UNIT-V: **(8 Hrs)**

ENGINE TESTING & PERFORMANCE

Engine Performance Testing & Characteristics - Testing and measurement equipment-dynamometers, Air & Fuel, temperature, in-cylinder Pressure and Crank angle.Emission Measurement- CLA, FID, NDIR, Analysers and Smoke meters. Variables Affecting Engine Performance, Performance Maps.

TEXT BOOKS:

1. IC Engines, M.L. Mathur & R.P. Sharma, DhanpatRai& Sons
2. Engine Emissions, Pollutant Formation and Advances in Control Technology, B.P. Pundir, Narosa Publishing House

Reference Books:

1. IC Engines Fundamentals, John B. Heywood, Mc Graw Hill Publications
2. Engineering Fundamentals of I C Engines, WiliardW.Pulkrabek, Prentice Hall Publications
3. Mixture Formation in Internal Combustion Engines, CarstenBaumgaten, Springer Pub
4. Thermal Engineering, PL Ballaney, Khanna Publishers, 25th Edition.

Course Outcomes: On the completion of the course the student will able to

CO's	Statements	Bloom's Level
CO1	Define engine glossaries, identify various components of SI and CI engines and its sub-systems	L1
CO2	Understand the actual engine working principle and its different induction and ignition systems.	L2
CO3	Exposed to gain knowledge on developments in cooling, lubrication, supercharging and turbocharging.	L2
CO4	Understand basic knowledge on SI and CI engine combustion and its related parameters	L2
CO5	Apply their knowledge in analyzing the engine performance and pollution characteristics.	L3

II B. Tech – II Semester

L	T	P	C
3	0	0	3

AUTOMOBILE ELECTRICAL AND ELECTRONICS

Course Objectives:

1. To define the glossary related to vehicle electrical and electronic system.
2. To understand the need for starter batteries, starter motor and alternator in the vehicle.
3. To differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols.
4. To list common types of sensor and actuators used in vehicles.
5. To understand networking in vehicles

UNIT-I: **(10 Hrs)**

Batteries and Accessories: Principle and Construction of Lead Acid Battery, Characteristics of battery, rating capacity and Efficiency of Batteries, Various Tests on Batteries, Maintenance and Charging. Lighting System: Insulated and Earth Return System, Details of Head Light and Side Light, LED Lighting System, Head Light Dazzling and Preventive Methods – Horn, Wiper System and Trafficator.

UNIT-II : **(10 Hrs)**

Starting System: Requirements of a Starting system, Behavior of Starter during Starting, Series Motor – Working Principle, construction and its Characteristics, Principle and Construction of Starter Motor, Working of Different Starter Drive Units, Care and Maintenance of Starter Motor, Starter Switches.

UNIT-III : **(8 Hrs)**

Charging System: Requirements of a Charging system – Alternators – Generation of electrical energy in vehicle- physical principles- Alternator and voltage regulations versions – power losses – characteristics curve- Alternator operation in the vehicle- Alternator circuitry.

UNIT-IV: **(8 Hrs)**

Fundamentals of Automotive Electronics: Engine Management System – PFI, GDI, CRDI and UI systems. Electro Magnetic Interference Suppression, Electromagnetic Compatibility, Electronic Dashboard Instruments, Onboard Diagnostic System, Security and Warning System.

UNIT-V : **(9 Hrs)**

Sensors & Actuators: Engine Sensors: Speed, Throttle Position, Exhaust Oxygen, knock, Manifold Pressure, Crankshaft Position, Temperature, Air Mass Flow.
Automotive Sensors: Impact Sensor, Rain Sensor, GPS Sensor, Speed Sensor.
Actuators: Solenoids, Stepper Motors, Relay.

Text Books

1. Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & NewPress-1999.
2. William B.Ribbens "Understanding Automotive Electronics", 5th edition -Butter worth Heinemann Woburn,1998.

References

1. Bechtold "Understanding Automotive Electronics", SAE,1998.
2. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
3. Judge A.W "Modern Electrical Equipment of Automobiles", Chapman & Hall, London,1992.
4. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi,1975.
5. Robert Bosch "Automotive Hand Book", SAE (5th Edition),2000.

Course Outcomes: On the completion of the course the student will able to

CO's	Statements	Bloom's Level
CO1	Define the glossary related to vehicle electrical and electronic system	L1
CO2	Understand the need for starter batteries, starter motor and alternator in the vehicle.	L2
CO3	Differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols.	L2
CO4	List common types of sensor and actuators used in vehicles.	L1
CO5	Understand networking in vehicles.	L2

II B. Tech – II Semester

L	T	P	C
3	0	0	3

METALLURGY & MATERIALS SCIENCE

COURSE OBJECTIVES: To understand the basic fundamentals of Material science and Physical metallurgy. The basic concepts to be taught will help for the improvement, proper selection and effective utilization of materials which is essential to satisfy the ever increasing demands of the society.

UNIT – I: **(10 Hrs)**

Structure of Metals and Constitution of alloys: Bonds in Solids, Metallic bond, crystallization of metals, Packing Factor-SC, BCC, FCC & HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries on the Properties of metal / alloys – determination of grain size. Imperfections– point, line, surface and volume-Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rotherys rules, intermediate alloy phases, and electron compounds.

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe3C.

UNIT – II: **(8 Hrs)**

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, greycastiron, Spheroidal graphitecastiron, Alloycastirons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Had field manganese steels, tool and diesteels.

Non-ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminum and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT – III: **(8 Hrs)**

Heat treatment of Alloys: Effect of alloying elements on Fe-Fe3C system, Annealing, normalizing, hardening, TTT diagrams, tempering, harden ability, surface-hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

UNIT – IV: **(10 Hrs)**

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization-Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Sintering Secondary operations-Sizing, coining, machining –Factors determining the use of powder metallurgy-Application of this process.

UNIT – V: **(9 Hrs)**

Ceramic and composite materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, various methods of component manufacture of composites, particle –reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal – matrix composites and C-Ccomposites. Nanomaterials –definition, properties and applications.

Text Books:

1. Introduction to Physical Metallurgy-Sidney H. Avener-McGraw Hill
2. Essential of Materials science and engineering-Donald R.Askeland-Cengage.

Reference Books:

1. Material Science and Metallurgy–Dr. V.D.kodgire-Everest Publishing House
2. Materials Science and engineering-Callister & Baala subrahmanyam-Wiley Publications
3. Materia lScience for Engineering students –Fischer– Elsevier Publishers
4. Material science nd Engineering-V.Rahghavan-PHI Publishers
5. Introduction to Material Science and Engineering–Yip-Wah Chung CRC Press
6. Material Science and Metallurgy–A V KSuryanarayana –BS Publications
7. Material Science and Metallurgy–U. C.Jindal –Pearson Publications

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand the crystal line structure of different metals and study the stability of phases in different alloy systems.	L2
CO2	Study the behavior of ferrous and non ferrous metals and alloys and their application indifferent domains	L1
CO3	understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals	L2
CO4	Grasp the methods of making of metal powders and applications of powder metallurgy	L2
CO5	Comprehend the properties and applications of ceramic, composites and other advanced methods.	L3

II B. Tech – II Semester

L	T	P	C
0	0	3	1.5

AUTOMOBILE ENGINES AND FUELS LAB

Course Objectives: To study the characteristics of the fuels and lubricants used in automobile and get practical knowledge in assembly & dismantling of engine components.

Note: Need to perform atleast Six Experiments from each of the Labs

PART-A: ENGINES LAB

LIST OF EXPERIMENTS

1. Draw the Valve and Port Timing Diagrams for 4S and 2S engines.
2. Evaluation of Performance and Emissions from 4S Petrol Engine
3. Evaluation of Performance and Emissions from 4S Diesel Engine
4. Evaluation of Frictional Power from the Morse Test on a 4-Stroke Multi Cylinder Engine
5. Determination of Frictional Power by the retardation and Motoring Test on IC Engine
6. Draw the Heat Balance Sheet for a 4-Stroke Petrol or Diesel Engine
7. Analysis of Combustion Characteristics like; P-θ, ~~Differential~~ Heat Release Rate, Cumulative Heat Release and Ignition Delay of diesel engine
8. Calculation of Stoichiometric Air- Fuel mixtures of Conventional fuels through oxidation Equation and compare with Spectrometric analysis
9. Calculation of Volumetric Efficiency of a conventional fuel and compare with Gas based Dual Fuel Operation, when secondary fuel is inducted through inlet manifold
10. Dismantling and Assembly of Agriculture single Cylinder and Multi- Cylinder Automotive Engines

PART-B: FUELS LAB

LIST OF EXPERIMENTS

1. To Perform the ASTM distillation test of liquidfuels.
2. Determining the different components available in a give fuel using Gas Chromatograph and quantify the same using Mass Spectrometry
3. Determining the Qualitative and Quantitative Analysis of given fuel by examining the IR spectrum peaks of the given fuel using FT-IR
4. To study the Structure and connectivity of Organic Molecules of given fuel using NMR C13/H1 analysis
5. To study the quantitative compositional data of hydrocarbon data using HPLC analysis using HPLC analyser
6. Determination of the Calorific value of liquid and gaseousfuel.
7. Determination of Flash and Fire points of petrol and diesel. (closed and opentype)
8. Determination of Temperature dependence of viscosity of lubricants & Fuels by RedwoodViscometer.
9. Determination of Viscosity index of lubricants & Fuels by SayboltViscometer.
10. Determination of Ash content and Carbon Residue Test.

11. Determination of flow properties of oil using Cloud and Pour pointTest.

Course Outcomes: Attending the laboratory the students shall be able to:

CO's	Statements	Bloom's Level
CO1	know the principles in assembly & dismantling of engine components	L1
CO2	learn characteristics of the fuels and lubricants used in automobile	L1

II B. Tech – II Semester

L	T	P	C
0	0	3	1.5

AUTOMOBILE ELECTRICAL AND ELECTRONICS LAB

Course Objectives:

1. To understand the working principle of Electrical circuits in automobile.
2. To evaluate the working principle of Battery, and starter motor.
3. To understand the working principle of auxiliary systems used in automobiles.
4. To understand the use of sensors in an automobile.
5. To develop a programing knowledge on Microprocessor

Note : Any 6 Experiments from each stream and rest can be considered as extra experiments

Part-A: Automotive Electrical Lab:

List of Experiments:

1. Testing and study of different types of Batteries and constructions.
2. Testing, dismantling and assembling of starter motor used in automobile.
3. Testing, dismantling and assembling of alternator used in automobile.
4. Study of different colour code system used in automotive wiring system.
5. Demonstration and study of Battery Ignition System and their parts used in Automobile Vehicles.
6. Study of different Electrical Equipment's & Accessories (Speedometer, Warning lights, Electric Horn, Wind shield wipers system).
7. Study of different sensors used in modern automotive system.
8. Study of various electronics system (Electronic fuel injection system, Electronicignition system, Air bag, ABS, Electronic fuel injector cleaner).
9. Demonstration and experiment on lighting system of ~~two wheeler and~~ Four Wheelers.
10. Demonstration, experiment and diagnosis on ignition system.

Part-B: Automotive Electronics:

List of Experiments:

1. Visualization of Engine Sensor Signals and fault Diagnosis using OBD Kit
2. Interface of Seven segment display
3. Interfacing of ADC for a sensor and Interfacing of DAC for an actuator
4. Interface circuit like amplifier, filter, Multiplexer and De Multiplexer
5. Basic microprocessor programming like arithmetic and Logic operation, code conversion,
6. waveform generation, look up table etc.
7. Study of Aurdino Programming
8. EPROM Programming
9. Study of Virtual Instrumentation and Communication Protocols (CAN, LIN, MOST etc.)

Course Outcomes: **Attending the laboratory the students shall be able to:**

CO's	Statements	Bloom's Level
CO1	Understand the working principle of Electrical circuits in automobile.	L2
CO2	Evaluate the working principle of Battery, and starter motor.	L5
CO3	Understand the working principle of auxiliary systems used in automobiles.	L2
CO4	Understand the use of sensors in an automobile.	L2

II B. Tech – II Semester

L	T	P	C
0	1	2	2

MACHINE TOOLS AND METROLOGY LAB

Note: minimum of 6 experiments from each section

Course Objective: This practical course covers the topics related to precession measuring instruments and the working and operations of various machine tools.

Part-A: METROLOGY LAB

1. Measurement of lengths, heights, diameters by vernier calipers, micrometers etc.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier calipers and checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.
5. Machine tool alignment test on milling machine.
6. Angle and taper measurements by bevel protractor, Sine bars etc.
7. Use of spirit level in finding the straightness of a bed and flatness of a surface.
8. Thread measurement by two wire/ three wire method & tool makers microscope.
9. Surface roughness measurement by Talysurf.

Part-B: MACHINE TOOLS LAB

- Study of general purpose machines -lathe, drilling machine, milling machine, shaper, planning machine, slotting machine, cylindrical grinder, surface grinder and tool and cutter grinder.

1. To perform Step turning and taper turning on lathe machine
2. To perform Thread cutting and knurling on lathe machine.
3. Development of models by Drilling and tapping.
4. Development of models byShaping and planning.
5. Development of models bySlotting
6. Development of models by Milling
7. To Perform Cylindrical surface grinding
8. To undergo Grinding of tool angles.

Course Outcome: After completing the course, the student will be able to operate various precession measuring instruments and working and operations of various machines tools. (L3)

L	T	P	C
1	0	2	2

II B. Tech – II Semester

DESIGN THINKING & INNOVATION

Course Objectives: The objectives of the course are to

- Bring awareness on innovative design and new product development.
- Explain the basics of design thinking.
- Familiarize the role of reverse engineering in product development.
- Train how to identify the needs of society and convert into demand.
- Introduce product planning and product development process.

UNIT – I Introduction to Design Thinking

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

UNIT - II Design Thinking Process

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT - III Innovation

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT - IV Product Design

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

UNIT – V Design Thinking in Business Processes

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

Textbooks:

1. Tim Brown, Change by design, 1/e, Harper Bollins, 2009.
2. Idris Mootee, Design Thinking for Strategic Innovation, 1/e, Adams Media, 2014.

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press, 2018.
2. Shrrutin N Shetty, Design the Future, 1/e, Norton Press, 2018.
3. William lidwell, Kritinaholden, &Jill butter, Universal principles of design, 2/e, Rockport Publishers, 2010.
4. Chesbrough.H, The era of open innovation, 2003.

Online Learning Resources:

- https://nptel.ac.in/courses/110/106/110106124/
- https://nptel.ac.in/courses/109/104/109104109/
- https://swayam.gov.in/nd1_noc19_mg60/preview
- https://onlinecourses.nptel.ac.in/noc22_de16/preview

Course Outcomes:

COs	Statements	Blooms Level
CO1	Define the concepts related to design thinking.	L1
CO2	Explain the fundamentals of Design Thinking and innovation.	L2
CO3	Apply the design thinking techniques for solving problems in various sectors.	L3
CO4	Analyse to work in a multidisciplinary environment.	L4
CO5	Evaluate the value of creativity.	L5

B.Tech. – III Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	Professional Core	Theory of Machines	3	0	0	3
2	Professional Core	Automobile Components and Chassis Design	3	0	0	3
3	Professional Core	Manufacturing Technology	3	0	0	3
4	Professional Elective - I	1. Facility Layout & Design 2. Automobile ECU Design and system Integration 3. Computer Vision & Image Processing 4. Alternative Fuels 5. Fuels and Lubricants 6. MOOC's/NPTEL	3	0	0	3
5	Open Elective-I	OR Entrepreneurship Development & Venture Creation 1. Basic Automobile Engineering 2. Automotive Electrical and Electronics 3. IC Engine Technology	3	0	0	3
6	Professional Core	Manufacturing Technology Lab	0	0	3	1.5
7	Professional Core	Material Testing Lab (MOS & MMS Lab)	0	0	3	1.5
8	Skill Enhancement course	Automobile Sketching & Drawing	0	1	2	2
9	Engineering Science	**Tinkering Lab**	0	0	2	1
10	Evaluation of Community Service Internship		-	-	-	2
Total			**15**	**1**	**10**	**23**

MC	Minor Course (Student may select from the same specialized minors pool)	3	0	3	4.5
MC	Minor Course through SWAYAM / NPTEL (Minimum 12 Week, 3 credit course)	3	0	0	3
HC	Honors Course (Student may select from the same Honors pool)	3	0	0	3
HC	Honors Course (Student may select from the same Honors Pool)	3	0	0	3

B.Tech. III Year II Semester

S.No.	Category	Title	L	T	P	C
1	Professional Core	Vehicle Dynamics	3	0	0	3
2	Professional Core	Vehicle Body Engineering	3	0	0	3
3	Professional Core	Hybrid and Electric Vehicle Technology	3	0	0	3
4	Professional Elective-II	1. Metal Forming & Press Working 2. Battery Technology 3. Machine Learning 4. Condition Monitoring 5. Engine Management Systems 6. MOOC's/NPTEL	3	0	0	3
5	Professional Elective - III	1. CFD for Automobile Applications 2. Modeling and Simulation in Manufacturing 3. Lean Manufacturing 4. Automobile HVAC 5. Sensors and Actuators 6. MOOC's/NPTEL	3	0	0	3
6	Open Elective – II	1. Two & Three Wheelers 2. Hybrid and EV Technology 3. Alternative fuels for IC Engines	3	0	0	3
7	Professional Core	Vehicle Evaluation Lab	0	0	3	1.5
8	Professional Core	Vehicle Maintenance Lab	0	0	3	1.5
9	Skill Enhancement course	Automobile ECU, Sensors and Actuators Integration Lab	0	1	2	2
10	Audit Course	Technical Paper Writing & IPR	2	0	0	-
Total			**20**	**1**	**08**	**23**
Mandatory Industry Internship of 08 weeks duration during summer vacation						
MC	Student may select from the same minors pool		3	0	3	4.5
MC	Minor Course (Student may select from the same specialized minors pool)		3	0	0	3
HC	Student may select from the same honors pool		3	0	0	3
HC	Honors Course (Student may select from the honors pool)		3	0	0	3

MINOR SPECIALIZATION

For the Honors/Minor Specialization student needs to complete 18 credits in addition to 160 credits.

Minors in Automobile Engineering					
S.NO.	**Title**	**L**	**T**	**P**	**Credits**
1	Basic Automobile Engineering	**3**	**-**	**-**	**3**
2	IC Engines	**3**	**-**	**-**	**3**
3	Vehicle Body Engineering	**3**	**-**	**-**	**3**
4	Automobile Electrical & Electronics Engineering	**3**	**-**	**-**	**3**
5	Electrical Vehicles and Hybrid Technology	**3**	**-**	**-**	**3**
6	Automobile Pollution and its effects	**3**	**-**	**-**	**3**
	Total				**18**

Honors in Automotive Design Engineering					
S.NO.	**Title**	**L**	**T**	**P**	**Credits**
1	Noise Vibrations and Harshness	**3**	**-**	**-**	**3**
2	Automobile Safety	**3**	**-**	**-**	**3**
3	Special Purpose Vehicles	**3**	**-**	**-**	**3**
4	Automobile Certification and Homologation	**3**	**-**	**-**	**3**
5	Vehicle Infotronics	**3**	**-**	**-**	**3**
6	Materials and Automotive Manufacturing Techniques	**3**	**-**	**-**	**3**
	Total				**18**

III Year I Semester	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study about the kinematic links, different types of pairs, mechanisms and principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism.
2. To understand the kinematic aspects of friction involved in machineries such as belts, clutches and brakes
3. To understand the basic concepts of toothed gearing and kinematics of gear trains.
4. To understand the motion resulting from a specified set of linkages and cam mechanisms for specified output motions.
5. To understand the undesirable effects of unbalancing resulting from prescribed motions in mechanism.

UNIT – I:

Mechanisms: Machine Structure – Kinematic link, pair and chain – Grublers criteria – Constrained motion – Degrees of freedom – Slider crank and crank rocker mechanisms – Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration

UNIT – II:

Friction: Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt (flat and V) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.

UNIT – III:

GEARS: Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicyclic gear trains – Determination of speed and torque.

UNIT – IV:

CAMS: Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions

BALANCING: Static and dynamic balancing – Single and several masses in different planes – Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multi-cylinder engines (Inline) – Balancing of radial V engine – direct and reverse crank method.

UNIT – V:

VIBRATION: Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi-rotor systems – Geared shafts – Critical speed of shaft.

Text Books:

1. Rattan.S.S, "Theory of Machines", Tata McGraw–Hill Publishing Co., New Delhi, 2004.
2. Ballaney.P.L, "Theory of Machines", Khanna Publishers, New Delhi, 2002.

Reference Books:

1. Rao,J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, Wiley Eastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", Satya Prakasam, Tech. India Publications, 1989.
3. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press, 1989.
4. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 1980.
5.Burton Paul, "Kinematics and Dynamic of Planer Machinery", Prentice Hall, 1979.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Demonstrate the fundamentals of mechanisms and their applications and able to analyse the kinematic properties of mechanism such as displacement, velocity and acceleration	L3
CO2	Analyse the effect of friction in machines such as belt drives, clutches and brakes	L4
CO3	Understand the basic nomenclature of gears and analyze gear kinematics	L2
CO4	Perform the kinematic analysis of cam and demonstrate the balancing of any kinematic system.	L3

III Year I Semester	AUTOMOBILE COMPONENTS AND CHASSIS DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1. To make students familiar with the constructional details of chassis and components.
2. To understand about various steering systems, steering linkages and steering gear boxes.
3. To understand the principle of suspension system.
4. To learn the gear box design .
5. To learn the principles of CVT

UNIT – I: Chassis Design

Center of Gravity and handling properties –Body weight & Body center of gravity – Mass Moment of Inertia. Vehicle Frame: Study of Loads –Moments and Stresses on Frame Members. Design of Frames for Passenger and Commercial Vehicle.

UNIT – II: Steering Design

Rack & Pinion: Advantages & Disadvantages, Configurations, Steering gear, manual with side tie rod takeoff, Steering gear, manual with centre tie rod take-off Recirculating Ball type: Advantages & Disadvantages, Steering Gear, Power Steering Systems: Hydraulic, Electro-Hydraulic and Electrical systems and Steering Kinematics: Maximum displacement of Rack, Calculation of inner and outer wheel angles, Length of Tie rod.

UNIT – III: Suspension System

Wheel travel requirement, Sprung & un-sprung mass distribution, Calculation of Tyre rolling radius, checking of camber change & Toe Change, front view swing arm length, side view swing arm length, Calculation of Jacking force & its effects on suspension, Camber change rate, Wheel base and wheel track change, Anti Dive and Anti- squat considerations

UNIT – IV: Gear Box Design

In-line shaft arrangement, Internal gear arrangement, Face-dog selectors, Bearing arrangement, Crown wheel and pinion layout, Differential location and type, Transverse-shaft arrangement, Selector system, Selector interlock system, Lubrication method and Gearbox casing.

UNIT – V: Continuous Variable Transmission (CVT)

Tuning of CVT: Speed & Power- Shift speed, engagement speed, power curves; Drive ratio & efficiency; Driven (secondary) clutch; Driving (primary) clutch; Pressure Spring; Fly weight System, Belt, and Gearing.

Text Books:

1. Automotive Chassis by Jonsen Reimpell, Butterworth Heinemann Pub, 2001.
2. Automotive Chassis Volume 1 by Giancarlo Genta & Lorenzo Morello, Springer, 2009.

3. Clutch Tuning Hand Book by Olav Aaeen, for serious racers and one who wants more performance from their variable ratio belt transmission.

Reference Books:

1. Automotive Chassis Volume 2 by Giancarlo Genta & Lorenzo Morello, Springer, 2009.
2. Manual Gear Box Design by Alec Stokes, SAE International, Butterworth Heinemann Pub, 1992.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Design the frames for the passenger and Commercial vehicles	L3
CO2	Design various vehicle components.	L3
CO3	Understand the different steering systems design	L2
CO4	Summarize the need for suspension systems and its types	L3

III Year I Semester	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the concepts and basic mechanics of metal cutting and the factors affecting machinability.
2. To learn working of basic and advanced turning machines.
3. To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4. To study the basic concepts of CNC of machine tools and constructional features of CNC.
5. To learn the basics of CNC programming concepts to develop the part programme for Machine centre and turning centre.

UNIT – I:

MECHANICS OF METAL CUTTING: Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT – II:

TURNING MACHINES: Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes-tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle

UNIT – III:

RECIPROCATING MACHINE TOOLS: Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

UNIT – IV:

CNC MACHINES: Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features**.**

UNIT – V:

PROGRAMMING OF CNC MACHINE TOOLS: Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

Text Books:

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,7th Edition, 2018.
2. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4th edition, 2018.

Reference Books:

1.Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984.
3. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw-Hill, New Delhi, 2009.
4. A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd edition, 2017.
5. Peter Smid, CNC Programming Handbook, Industrial Press Inc.;Third edition, 2007.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Apply the mechanism of metal removal process and to identify the factors involved in improving machinability.	L3
CO2	Describe the constructional and operational features of centre lathe and other special purpose lathes.	L2
CO3	Describe the constructional and operational features of reciprocating machine tools.	L2
CO4	Apply the constructional features and working principles of CNC machine tools.	L3
CO5	Demonstrate the CNC machine tools Program through planning, writing codes and setting up CNC machine tools to manufacture a given component.	L2

III Year I Semester	FACILITY LAYOUT & DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The aim of this course is to make students understand the importance of facility layout design and its impact on productivity. Students can get acquainted with different types of computerized layout improvement approaches. The course is also aimed at imparting knowledge of plant layout and material handling aspects to students

UNIT – I

Introduction: Facilities design function- Scope, Objectives, need for layout study, types of layout problem, Types of flow pattern, Types of plant layout, Nature, Significance and Scope of Facilities Layout Planning, Facility design procedure

Plant location: Plant location analysis-factors, costs, Facility location: Single facility location problem, Multiple facility location problem, Gravity facility location problem, Euclidean distance location problem

UNIT II

Activity relationship analysis: Activity relationship diagram, worksheet, dimensionless block diagram, Flow analysis, Computer generated REL chart

Layout design: Design cycle - SLP procedure manpower, machinery requirements – Computer algorithms - ALDEP, CORELAP, CRAFT.

UNIT III

Quantitative methods: Group technology-Production Flow analysis (PFA), ROC (Rank Order clustering), Quantitative analysis in cellular manufacturing.

Manual Assembly Lines: Assembly workstations, Analysis of Single model assembly lines, Line balancing problems, Line balancing algorithm: i) Largest candidate rule ii) Kilbridge and wester method iii) Ranked positional weight method iv) COMSOAL, Mixed model assembly lines, Line of balance

UNIT IV

Auxiliary Services Requirement Space: Receiving and shipping, Storage, Warehousing, Maintenance and Tool room, Utilities and Lighting.

Employee Services-Space requirements: Parking lot, Employee entrances, Locker rooms, Toilets and Restrooms, Lunch room, Recreation, Drinking fountains, Aisles, Medical facilities

UNIT V

Materials handling: Cost justification, Goals of material Handling, Principles of material handling, MH problem solving procedure, Unit load concept, and material handling system design.

Material Handling Equipment: Receiving and shipping, Stores, Fabrication, Assembly, Shop floor, Warehousing, Packaging. Computer integrated material handling system

Reference Books:

1. Plant layout & Material Handling, G. K. Agrawal, Jain Publishers, New Delhi.
2. Automation, Production Systems and Computer Integrated Manufacturing, 2nd edition, Mikell P. Groover, Prentice Hall of India, New Delhi, 2003.
3. Plant Layout & Material Handing, 3rd edition, J.M Apple, John Wiley & Sons, 1972, New York.
4. Production and Operations Management, 3rd edition, R. Panneerselvam, PHI Learning Private Ltd., New Delhi, 2012.
5. Facilities planning, J. A. Tompkins and J. A. White, John Wiley, 1984.
6. Facilities Layout and Location: An analytical approach, Richard Francis L. and John A. White, Prentice Hall Inc., 1984.
7. Plant Layout and Design, Moore, J. M. Macmillan Company, New York, 1970.
8. Manufacturing Facilities Design, 2nd edition, Fred F. Meyers, Matthew P. Stephens, Prentice Hall, New Jersey.
9. Practical Plant layout, Richard Muther, McGraw Hill Book Company, New York
10. Facilities Planning and Materials Handling, Vijay Sheth, Marcle Decker, New York.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand the concept of Facility planning and layout design	L2
CO2	Know the concept of Facility location problem in different areas.	L2
CO3	Understand the concept of Activity Relationship Diagram	L2
CO4	Understand different line balancing algorithms and their use.	L3
CO5	Understand how to generate computerized layout solutions for plant layout design problem.	L3

III Year I Semester	AUTOMOBILE ECU DESIGN AND SYSTEM INTEGRATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

This course aims to equip students with the knowledge and skills to design, develop, and integrate Electronic Control Units (ECUs) in automotive systems, focusing on understanding ECU architecture, software, hardware, and communication protocols, along with vehicle integration and testing.

UNIT I:

ECU DESIGN CONCEPT

The concepts of ECU design for automotive applications- Need for ECUs- advances in ECUs for automotive- design complexities of ECUs-V-Model for Automotive ECU ‘s Architecture of an advanced microcontroller used in the design of automobile ECUs -analog and digital Interfaces-Controllers for ECUs: Understanding different ECUs in an automobile-challenges and design requirements of ECU design - selection of sensors and interfaces for ECU design.

UNIT II:

MATHEMATICAL MODELING AND VALIDATION

Top level blocks diagram development for ECUs- design of software modules and hardware modules for ECU design- mathematical modeling of automotive Applications-Designing-modelling and porting of software models on ECUs-development of test setup for ECU testing- System level testing: Experimental setup for ECU validation-system level optimization for cost- reliability check and endurance check of ECUs- signal integrity check and EMI/EMC analysis- integration of ECUs into automotive

UNIT III:

MODEL BASED SYSTEM DESIGN

Introduction to Model based system design -hardware in-the-loop simulation- continuous and discrete simulation basics-modeling basics. Connection between Hardware and Simulation-Coupling concepts-simulator coupling and co-simulation, synchronization of co-simulations, basic coupling principles- Event Discrete Simulation-Real Time Workshop-Introduction to basic Simulink blocks, xPC target, Real Time Workshop-State flow and Real Time Embedded coder

UNIT IV:

MODEL BUILDING WITH SIMULINK

Model Building with Simulink: Controller programming using model based system design for an automotive application using Simulink-Plant Modelling- Plant modelling using Simulink for the automotive application-PID controller design, analog output, targeting a processor for plant Hardware Implementation-Design of ECU for automotive applications, interfacing of sensors and Actuators-System modelling and validation using test setup-Interfacing of software models with hardware design.

UNIT V:
HARDWARE IN LOOP SIMULATION

System programming and development of experimental setup for hardware in loop simulation. Hardware in-the-Loop-Testing of plant separately, testing of controller separately and testing of plant and controller in the loop-System Verification and Validation-Comparing the HIL test results with real world result Hardware in-the-Loop testing- Experimental setup for HIL-HIL testing using dSPACE micro autobox, introduction to carmaker, building scenarios and vehicle analysis using carmaker- interfacing dSPACE with carmaker and case studies on micro autobox.

TEXT BOOKS:

1. Frank Vahid and Tony Givargis, Embedded System Design, 2012
2. John Wiley & Sons Ronald K. Jurgen, A Unified Hardware/Software Introduction, Automotive Electronics Handbook, McGraw-Hill, 2013
3 Hall, Douglas V, Microprocessors and Interfacing: Programming and Hardware, 2nd edition, Tata McGraw Hill, 2014

REFERENCES:

1.David E. Simon, An Embedded Software Primer, Pearson Education, 2015
2. Ferguson, Colin R, Kirkpatrick, Allan T., Internal Combustion Engine - 2014

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Familiarize on concepts of ECU design for automotive applications.	L2
CO2	Gain knowledge on software modules and hardware modules for ECU design	L3
CO3	Acquire the knowledge to solve complex problems in Model based system design & hardware in-the-loop simulation	L3

III Year I Semester	COMPUTER VISION & IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

This course will provide students with more techniques in the digital image processing for image enhancement, restoration of noisy images, Segmentation and various machine learning techniques. Emphasis is given more on implementation of various algorithms so that students will able to develop their own algorithm. The techniques covered in the syllabus have wide applicability in any field which needs to handle the image data.

UNIT I

Digital Image Fundamentals:

Light and Electromagnetic spectrum, Components of Image processing system Image formation and digitization concepts, Neighbours of pixel adjacency connectivity, regions and boundaries, Distance measures, Applications.

UNIT II

Image Enhancements:

In spatial domain: Basic gray level transformations, Histogram processing, Using arithmetic/Logic operations, smoothing spatial filters, Sharpening spatial filters. In Frequency domain: Introduction to the Fourier transform and frequency domain concepts, smoothing frequency-domain filters, Sharpening frequency domain filters

UNIT III

Image Restoration:

Various noise models, image restoration using spatial domain filtering, image restoration using frequency domain filtering, Estimating the degradation function Inverse filtering.

UNIT IV

Colour Image Processing

Color fundamentals, Color models, Color transformation – Algorithms **Image Segmentation:** Detection of discontinuities, Edge linking and boundary detection, thresholding**.**

UNIT V

Computer Vision:

Feature descriptors: HOG SIFT SURF, Object detection and tracking, Object recognition, Motion detection, Principal Component analysis, Intelligent video surveillance

Applications: Face detection, Vehicle detection, pedestrian detection, Suspicious activity detection and recognition, Crowd detection, Medical imaging for disease detection

Reference Books:

1.Digital Image Processing, Rafel C. Gonzalez and Richard E. Woods, Publisher: Pearson Education

2.Digital Image Processing, Bhabatosh Chanda and Dwijesh Majumder, Publisher: 3.PHI Computer Vision - A modern approach, D. Forsyth and J. Ponce, Publisher: Prentice Hall

4.Feature Extraction & Image Processing for Computer Vision, Mark Nixon and Alberto S. Aquado, Third Edition, Academic Press, 2012

5.John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand the basic image enhancement techniques in spatial and frequency domains.	L2
CO2	Understand the various kind of noise present in the image and how to restore the noisy image	L3
CO3	Understand various segmentation methods and to apply this concept for image handling in various fields	L2
CO4	To develop applications using computer vision techniques	L4

III Year I Semester	ALTERNATIVE FUELS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To impart the necessity of finding alternative energy sources for automobiles and to understand merits and demerits, performance characteristics of various sources of fuels and their comparison.

UNIT – I

CONVENTIONAL FUELS FOR I.C. ENGINES: Petroleum based conventional fuels for SI and CI engine, Demand and Availability of crude oil – vehicle population increase – national and international standards for conventional and alternative fuels. Desirable characteristics of SI Engine fuels – Petrol – Properties, Specification, chemical structure, Volatility characteristics, knock rating and additives. Desirable characteristics of CI Engine fuels – Diesel – Properties, Specification, chemical structure, Ignition quality, Cetane rating and additives.

UNIT – II

ALCOHOLS AS FUELS: Availability of different alternative fuels for engines. Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission characteristics in engines. Advantages and disadvantages of alcohol fuels

UNIT – III

VEGETABLE OILS AND BIODIESEL AS FUELS: Properties of Vegetable oils and biodiesel- Methods of using vegetable oils – Blending, preheating, and emulsification – Preparation of biodiesel from non-edible, edible oil and Algae - Performance, combustion and emission Characteristics in diesel engines. Advantages and disadvantages of Vegetable oils and biodiesel

UNIT – IV

HYDROGEN AS FUEL: Hydrogen – Properties, Production methods, storage and safety aspects. Methods of using hydrogen in engines. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Hydrogen fuel.

UNIT – V

BIOGAS, CNG AND LPG AS FUELS: Biogas, Compressed Natural gas (CNG) and LPG – Properties and production methods. CO2 and H2S scrubbing in Biogas, Modifications required for use in Engines- Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Gaseous fuels. ~~Working of~~ LPG and CNG kits used in automotive engines.

Reference Books:

1. Arumugam S. Ramadhas, "Alternative Fuels for Transportation" CRC Press, 2011.
2. Ayhan Demirbas and M. Fatih Demirbas, "Algae Energy-Algae as a New Source of Biodiesel", Springer-Verlag London Limited 2010.
3. Ayhan Demirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer-Verlag London Limited 2008.
4. David M. Mousdale, "Introduction to Biofuels", CRC Press, 2015.
5. Ganesan.V., "Internal Combustion Engineering", Tata McGraw-Hill Publishing Co., New Delhi, 2003.
6. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
7. M. K. Gajendra Babu and K. A. Subramanian, "Alternative Transportation Fuels-Utilisation in Combustion Engines", CRC Press, 2013.
8. M.L. Mathur, R.P.Sharma "A course in internal combustion engines", Dhanpatrai publication, 2003.
9. Richard L Bechtold P.E.,Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Possess a comprehensive understanding of available alternative fuels for IC engines. They will possess complete knowledge on producing different biofuels, modifying them and using them in IC engines.	L2
CO2	Acquire the skills in developing new technologies for alternative fuels efficiently in IC engines.	L3
CO3	Demonstrate the importance of using alternative fuels for sustainable energy supply and for emission control in IC engines.	L3

III Year I Semester	FUELS AND LUBRICANTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The objective of this course is to prepare the students to understand the role, properties and testing of various fuels and lubricants in the design and operation of IC engines

UNIT-I: REFINERY OF FUELS AND LUBRICANTS

Introduction to Structure of petroleum, refining Process-Distillation, cracking processes, Catalytic reforming, alkylation, isomerisation and polymerization, finishing process-blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

UNIT-II: THEORY OF LUBRICATION

Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elastic hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system

UNIT-III: LUBRICANTS

Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, additives and additive mechanism, synthetic lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease- lubricants for gearbox, brake, differential and steering systems

UNIT-IV: PROPERTIES AND TESTING OF FUELS

Properties and testing of fuels- density, calorific value, cetane and octane number, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, cloud and pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion. Test on used lubricants. Biofuel- properties and testing.

UNIT-V: TESTING INSTRUMENTS

Working principles and types – viscometers, calorimeters, flash and fire point apparatus, cloud and pour point apparatus, distillation apparatus, carbon residue apparatus, CFR engine, vapour pressure testing, copper strip, Aniline point apparatus -Ash content testing equipment - specifications of fuels. ASTM and SAE standards - FTIR- GCMS analysers.

Text Books:

1.Ganesan.V., "Internal Combustion Engines", Tata McGraw-Hill Publishing Co., New Delhi, 2017.
2. George E. Totten, Editor, Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing, ASTM International.

Reference Books:

1. Paul Richards "Automotive fuels reference book" SAE International, Third edition 2014.
2. Roger Frederick Haycock, John Hillier, Arthur J. Caines "Automotive lubricants Reference book", SAE International, Second edition 2004.
3. Wilfrid Francis– Fuels and Fuel Technology, Vol. I & II

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Analyse the behaviour of fuels and lubricants	L3
CO2	Select suitable fuel and lubricant testing equipment	L3
CO3	Evaluate the properties of fuels and lubricants	L2
CO4	Understand the properties of fuels and lubricants and its testing equipment	L2
CO5	Identify the fuels and lubricants for automotive applications	L3

III Year I Semester	BASIC AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE: aims to provide students with foundational knowledge of vehicle systems, components, and operations, enabling them to identify, explain, and analyze vehicle performance and troubleshoot issues.

UNIT-I:

Introduction: Layout of automobile chassis and body components. types of Automobile engines. – power unit –engine lubrication – engine servicing.

Fuel System: S. I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters – carburettor – types – air filters – petrol injection. Introduction to MPFI and GDI Systems.

C.I. Engines: Requirements of diesel injection systems, types of injection systems, DI Systems. fuel pump, nozzle, injection timing. Introduction to CRDI and Turbocharger Systems.

UNIT – II:

Cooling System: Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporative cooling – pressure sealed cooling – antifreeze solutions.

Ignition System: Function, battery ignition system, storage battery, auto transformer, Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

Electrical System: Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator.

UNIT – III:

Transmission System: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, constant mesh, synchro mesh gear boxes, Introduction to automatic transmission systems. Propeller shaft, universal joint, differential rear axles wheels and tyres.

Suspension System: Objectives – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

UNIT-IV:

Braking System: Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder Requirement of brake fluid, Pneumatic and vacuum brakes.

Steering System: Steering geometry – camber, castor, king pin rake, combined angle toe-in and toe-out,. Types of steering mechanism – Ackerman and Davis, Introduction to power steering, steering linkages.

UNIT – V:

Emissions from Automobiles: Pollution standards National and international – Pollution Control Techniques – Catalytic Convertor, SCR, Particulate filter, DOC.

Energy alternatives: Solar Photo-voltaic, hydrogen, Biomass, alcohols, LPG, CNG, Hydrogen as a fuel for IC Engines. - their merits and demerits.

TEXT BOOKS:

1. Automobile Engineering / William H Crouse.
2. Automobile Engineering (Vol 1) Kirpal Singh
3. Fundamentals of IC Engines – V. Ganesan

REFERENCE BOOKS:

1. Automotive Mechanics / Heitner.
2. Automotive Engineering / Newton Steeds & Garrett.
3. Introduction to IC Engines Mathur & Sharma

Course Outcomes: On the completion of the course the student will be able to

CO's	Statements	Bloom's Level
CO1	To understand basics of automobile engineering, conversant with drive train and transmission.	L2
CO2	conversant with suspension and brake system.	L3
CO3	Understand basics of vehicle performance.	L3
CO4	Conversant with automobile electrical systems and maintenance.	L2

III Year I Semester	AUTOMOTIVE ELECTRICAL AND ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To define the glossary related to vehicle electrical and electronic system.
2. To understand the need for starter batteries, starter motor and alternator in the vehicle.
3. To differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols.
4. To list common types of sensor and actuators used in vehicles.
5. To understand networking in vehicles

UNIT-I:

Batteries and Accessories: Principle and Construction of Lead Acid Battery, Characteristics of battery, rating capacity and Efficiency of Batteries, Lighting System: Insulated and Earth Return System, Details of Head Light and Side Light, LED Lighting System, Head Light Dazzling and Preventive Methods – Horn, Wiper System and Trafficator.

UNIT-II:

Starting System: Requirements, Series Motor – Working Principle, construction and its Characteristics, Principle and Construction of Starter Motor, Starter Switches.

UNIT-III:

Charging System: Requirements– Alternators –Working Principle – power losses – characteristics curve- Alternator operation in the vehicle- Alternator circuitry.

UNIT-IV:

Engine Sensors: Speed, Throttle Position, Exhaust Oxygen, knock, Manifold Pressure, Crankshaft Position, Temperature, Air Mass Flow.

Automotive Sensors: Impact Sensor, Rain Sensor, GPS Sensor, Speed Sensor.

Actuators: Solenoids, Stepper Motors.

UNIT-V:

Fundamentals of Automotive Electronics: –Engine Management System – PFI, GDI and CRDI, Electronic Dashboard Instruments, Onboard Diagnostic System, Security and Warning System.

Text Books

1. Young A.P. & Griffiths. L. "Automotive Electrical Equipment", ELBS & NewPress-1999.
2. William B.Ribbens "Understanding Automotive Electronics", 5th edition -Butter worth Heinemann Woburn,1998.

References

1. Bechtold "Understanding Automotive Electronics", SAE,1998.
2. Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
3. Judge A.W "Modern Electrical Equipment of Automobiles", Chapman & Hall, London,1992.
4. Kholi.P.L "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi,1975.
5. Robert Bosch "Automotive Hand Book", SAE (5th Edition),2000.

Course Outcomes: On the completion of the course the student willable to

CO's	Statements	Bloom's Level
CO1	Define the glossary related to vehicle electrical and electronic system	L1
CO2	Understand the need for starter batteries, starter motor and alternator in the vehicle.	L2
CO3	Differentiate the conventional and modern vehicle architecture and the data transfer among the different electronic control unit using different communication protocols.	L2
CO4	List common types of sensor and actuators used in vehicles.	L1
CO5	Understand networking in vehicles.	L2

III Year I Semester	IC ENGINE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

- To impart the knowledge and providing holistic view on IC Engines and its developments
- To enable the students to calculate the performance and testing of IC engines
- To fetch with SI & CI fuelling system and combustion behaviour and its advancements to meet the stringent emission norms
- Understanding the formation and control strategies of SI and CI Engine emissions

UNIT-I

Engine Principles: Introduction, Comparison of Air Standard and Actual Cycles, Constructional Details of Four Stroke SI and CI Engines, Working Principle, Actual Indicator Diagram, Two Stroke Engine Construction and Operation, Comparison of Four Stroke and Two Stroke Engine Operation, Firing Order and Its Significance.

UNIT-II

ENGINE TESTING & PERFORMANCE

Engine Performance Testing & Numerical- methods and Performance Characteristics; Performance Maps. Lubrication and Cooling systems, Introduction to Supercharging and Turbocharging; Introduction to Engine Cooling and Lubrication

UNIT-III

SI ENGINE COMBUSTION

Carburettor Working Principle, Requirements of an Automotive Carburettor, and types, Fuel Injection Systems; Pre-mixed charge combustion, SI Engine Combustion Conceptual models, Knocking Combustion

UNIT-IV:

CI ENGINE COMBUSTION

Fuel Injection and Spray Structure: Fuel Atomization. Diesel Combustion Process Characterization: Ignition Delay, Effect of Engine and Operational Parameters on Delay, Pre-mixed Combustion and Mixing Controlled Combustion.

UNIT-V:

ADVANCED COMBUSTION MODES

GDI, Flexi Fuel, CAI, Introduction to Low Temperature Combustion Like: Homogeneous Charge Compression Ignition(HCCI), Fuel Stratified Charge combustion/ Reactivity Controlled Compression Ignition (RCCI) and Pre-mixed Charge Compression (PCCI) technologies.

Text Books:

1. IC Engines, M.L. Mathur & R.P. Sharma, Dhanpath Rai & Sons
2. Engine Emissions, Pollutant Formation and Advances in Control Technology, B.P.

Pundir, Narosa Publishing House

Reference Books:

1. IC Engines Fundamentals, John B. Heywood, Mc Graw Hill Publications
2. Engineering Fundamentals of I C Engines, WiliardW.Pulkrabek, Prentice Hall Publications

Course Outcomes: At the end of the course, the students should be able to

CO's	Statements	Bloom's Level
CO1	Differentiate the ideal, air standard cycles and actual thermodynamic cycles.	L2
CO2	Evaluate the Engine performance based on the experimental data	L3
CO3	Analyse the fueling system and combustion behaviour of SI engines	L3
CO4	Analyse the fueling system and combustion behaviour of CI engines	L3
CO5	Explain the formation of emissions and its control strategies of bot SI & CI Engines.	L2

III Year I Semester	MANUFACTURING TECHNOLOGY LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

1.To Selecting appropriate tools, equipment's and machines to complete a given job.

2 To Performing various welding process using GMAW and fabricating gears using gear making machines.

3 To Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analysing the defects in the cast and machined components.

Note: Need to perform atleast Six Experiments from each of the Labs

LIST OF EXPERIMENTS

(8 out of 12)

1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2. Preparing green sand moulds with cast patterns.
3. Taper Turning and Eccentric Turning on circular parts using lathe machine.
4. Knurling, external and internal thread cutting on circular parts using lathe machine.
5. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
6. Drilling and Reaming using vertical drilling machine.
7. Milling contours on plates using vertical milling machine.
8. Cutting spur and helical gear using milling machine.
9. Generating gears using gear hobbing machine.
10. Generating gears using gear shaping machine.
11. Grinding components using cylindrical and centerless grinding machine.
12. Grinding components using surface grinding machine.

COURSE OUTCOMES: Attending the laboratory the students shall be able to:

	Statements	Bloom's Level
CO1	Demonstrate the safety precautions exercised in the mechanical workshop and join two metals using GMAW.	L3
CO2	make the work piece as per given shape and size using machining process such as rolling, drawing, turning, shaping, drilling and milling.	L3
CO3	make the gears using gear making machines and analyze the defects in the cast and machined components.	L4

III Year I Semester	MATERIAL TESTING LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

To impart practical exposure on the microstructures of various materials and their hardness evaluation. Also to impart practical knowledge on the evaluation of material properties through various destructive testing procedures.

Part-A: MECHANICS OF SOLIDS:

List of Experiments:

1. Direct tension test
2. Bending teston
   a) Simple supported beam
   b) Cantilever beam
3. Torsion test
4. Hardness test
   a) Brinell hardness test
   b) Rockwell hardness test
5. Test on springs
6. Compression test
7. Impact test
8. Punch shear test

Part-B: METALLURGY LAB:

List of Experiments:

1. Preparation and study of the Microstructure of pure metals like Iron, Cu andAl.
2. Preparation and study of the Microstructure of Mild steel, Medium carbon steels, High carbon steels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrous alloys.
5. Study of the Micro structures of Heat treated steels.
6. Study of Hardenability of steels
7. Study of Hardness of various treated and untreated steels.

COURSE OUTCOMES: Attending the laboratory the students shall be able to:

CO's	Statements	Bloom's Level
CO1	Identify and analyse mechanical properties such as strength, hardness, toughness, and ductility of different materials.	L2
CO2	Perform standard material tests including tensile, compression, shear, impact, hardness, and fatigue testing.	L3
CO3	investigate the failure modes of materials under different loading conditions.	L5

CO4	Apply test results to enhance material selection and design considerations in engineering applications.	L3

III Year I Semester	AUTOMOBILE SKETCHING & DRAWING	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:

1. To familiarize with the fundamental knowledge in the field of automotive drawing.
2. To acquaint with required analytical abilities to provide solutions to design problems**.**

Using CAD Software

UNIT – I: Draw the Layout of different vehicle architectures

1. Layout of Fuel filing cum service station
2. Layout of EV infrastructure
3. Free hand sketching of different automobiles

UNIT – II: Draw different Engine Components

Draw the dimensioned sketches of the following automobile engine components

1. 2-Stroke and 4-stroke petrol engine pistons
2. Diesel engine pistons
3. 4-cylinder and 6-cylinder engine crank shaft
4. 4-cylinder and 6-cylinder engine cam shaft

UNIT – III: AXLES AND TYRES

Construction and Design of Drive Axles, Types of Loads acting on drive axles, Full – Floating, Three– Quarter Floating and Semi–Floating Axles, Axle Housings and Types – Lift axle, Dead axle, Types and Constructional Details of Different Types of Wheels and Rims, Different Types of Tyres and their constructional details.

UNIT – IV: Draw the Assembly drawing of various Engine components

Assembly drawing of,

1. Connecting rod
2. Assembly of single cylinder engine
3. Overhead & side valve mechanism with all parts (with side cam shaft and overhead cam shaft)
4. Spark plug & fuel injector

UNIT – V:

Design of Cam and Follower: Roller follower mechanism with spring and shaft Design of valves and valve operating mechanism

Design and selection of belts- Flat - belt and V- belt with pulley construction and Roller chain

Reference Books:

1. N.D.Bhatt - Machine Drawing – Charotar publishing house pvt. ltd
2. P.I.Varghese - Machine Drawing - VIP Publishers
3. R.B.Gupta - Automobile Engineering Drawing – Satyaprakasan pub
4. Automobile body building - T.T.T.I – Chennai
5. Anil Chikkara - Automobile Engg., Vol. 3 –Satyaprakasanpub

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Identify the different types of frame and chassis used in Automotive.	L2
CO2	Relate different types of drive lines and drives used in Automotive.	L2
CO3	Acquire knowledge about different types of front axle and rear axles used in motor vehicles.	L2
CO4	Examine the working principle of conventional and independent suspension systems.	L4
CO5	Apply knowledge on working principles of brake and its subsystems.	L3

III Year I Semester	TINKERING LAB	L	T	P	C
		0	0	2	1

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge. Some specific goals are:

1. Encourage Innovation and Creativity
2. Hands-on Learning
3. Skill Development
4. Foster Collaboration and Teamwork
5. Interdisciplinary Learning
6. Problem-Solving mind-set
7. Prepare for Industry and Entrepreneurship

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of experiments: (8 out of 11)

1) Make your own parallel and series circuits using breadboard for any application of your choice.
2) Demonstrate a traffic light circuit using breadboard.
3) Build and demonstrate automatic head light using LDR.
4) Simulate the Arduino LED blinking activity in Tinkercad.
5) Build and demonstrate an Arduino LED blinking activity using Arduino IDE.
6) Interfacing IR Sensor and Servo Motor with Arduino.
7) Blink LED using ESP32.
8) LDR Interfacing with ESP32.
9) Control an LED using Mobile App.
10) Design and 3D print of a simple automobile component
11) Demonstrate all the steps in design thinking to redesign a motor bike.

Students need to refer to the following links:

1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf
4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf

III Year II Semester	VEHICLE DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for

1. Provide fundamental knowledge of the vibration,
2. Impart knowledge on tyres
3. Provide basic concepts on suspension design and function, ride modes
4. Evaluate the performance, longitudinal dynamics and control in an automobile
5. Provide basic analysis on handling, cornering stability and control

UNIT – I

CONCEPT OF VIBRATION:

Modelling and Simulation, Global and Vehicle Coordinate System. Fundamentals of vibration - Definitions, Types, Free, Forced, Undamped and Damped Vibration. Vibration analysis – Formulation of Governing equation. Response Analysis of Single DOF, Two DOF, Multi DOF. Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT – II

TYRES:

Tyre axis system, Construction and manufacturing of tires, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance. Tire slip – Longitudinal slip and slip angle concept, Relation between tractive effort and longitudinal slip, Friction circle. Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Camber and camber trust. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre. Tyre models.

UNIT – III

VERTICAL DYNAMICS:

Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. MR & ER Dampers. Design and analysis of Passive, Semiactive and Active suspension using Quarter car, Bicycle Model, Half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties

UNIT – IV

LONGITUDINAL DYNAMICS AND CONTROL:

Aerodynamic forces and moments. Forces acting on a vehicle – Resistance forces, Traction force supplied by power plant. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Longitudinal load transfer during acceleration and braking. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

UNIT – V

LATERAL DYNAMICS:

Steering Geometry – Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Directional stability. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Roll dynamics - Roll center, Roll axis, effect of roll on vehicle dynamics. Yaw control. Stability control

Text Books:

1. Singiresu S. Rao, "Mechanical Vibrations – SI Edition," Sixth Edition, Pearson, 2018 2. J. Y. Wong, "Theory of Ground Vehicles", Fifth Edition, Wiley-Inter science, 2022
3. Rajesh Rajamani, "Vehicle Dynamics and Control," Second edition, Springer,2012
4. Reza N. Jazar, "Vehicle Dynamics: Theory and Application", Third edition, Springer, 2017

Reference Books:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Revised Edition, Society of Automotive Engineers Inc, 2021
2. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013
3. Michael Blundell & Damian Harty, "The Multi body Systems Approach to Vehicle Dynamics", 2nd Edition, Butterworth - Heinemann,2014
4. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, Butterworth - Heinemann, 2006

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Develop physical and mathematical models of a mechanical vibrating system	L6
CO2	Indicate the forces and moment acting on tyres	L 4

CO3	Identify the suspension parameters that governs ride comfort	L 2
CO4	Evaluate the vehicle performance in longitudinal direction.	L 5
CO5	Evaluate the lateral dynamics and control in an automobile.	L5

III Year II Semester	VEHICLE BODY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To acquire knowledge on Different aspects of car body,
2. To acquire knowledge on bus body and commercial vehicle bodies.
3. To acquire knowledge on Role of various aerodynamic forces and moments, measuring instruments in vehicle body design.
4. To acquire knowledge on Material used in body building,
5. To acquire knowledge on Tools used in body repairs and command over vehicle body engineering applications.

UNIT – I

CAR BODY DETAILS:

Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car body terminology - Visibility- regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design -Car body construction-Various panels in car bodies. Safety: Safety design, safety equipment for cars. AIS and SAE car body Regulations

UNIT – II

BUS BODY DETAILS:

Types of bus body: based on capacity, distance travelled and based on construction.– Bus body lay out, floor height, engine location, entrance and exit location. Types of metal sections used –Constructional details: Conventional and integral. AIS and SAE bus body Regulations.

UNIT – III

COMMERCIAL VEHICLE DETAILS:

Types of commercial vehicle bodies - Light commercial vehicle body. Construction details of Flat platform body, Tipper body and Tanker body – Dimensions of driver's seat in relation to controls – Drivers cab design**.**

UNIT – IV

VEHICLE AERODYNAMICS:

Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels – Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test – measurement of various forces and moments by using wind tunnel balance.

UNIT – V

BODY MATERIALS, TRIM, MECHANISMS AND BODY REPAIR:

Types and properties of materials used in body construction and insulation -Such as steel sheet, timber, plastics and GRP, Insulation materials. Body trim items-body mechanisms. Hand tools-power tools for body repair. Vehicle corrosion-Anticorrosion methods-Modern painting process procedure.

Text Books:

1. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2. Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007.

Reference Books:

1. Dieler Anselm., The passenger car body, SAE International, 2000
2.Powloski, J., Vehicle Body Engineering, Business Books Ltd., 1998.
3.James E Duffy, Body Repair Technology for 4-Wheelers, Cengage Learning, 2009.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Understand the different aspects of car body	L2
CO2	Differentiate the bus and commercial vehicle bodies.	L4
CO3	Describe the role of various aerodynamic forces and moments, measuring instruments in vehicle body design..	L4
CO4	Identify the materials used in body building	L5
CO5	Select hand tools for body repairs and maintenance.	L3

III Year II Semester	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The course should enable the students to:

1. General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
2. Understand about vehicle dynamics,
3. Design the required energy storage devices,
4. Select the suitable electric propulsion systems and
5. Understand of hybrid electric vehicles**.**

UNIT – I

NEED FOR ALTERNATIVE SYSTEM

Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles .Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT – II

DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems

UNIT – III:

ENERGY SOURCES

Battery Parameters- - Different types of batteries – Lead Acid- Nickel based-Sodium based Lithium based- Metal Air based. Battery Modeling- Equivalent circuits, Battery charging-Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System

UNIT – IV

MOTORS AND CONTROLLERS

Types of Motors, Characteristic of DC motors, AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/DC converters

UNIT – V

SUBSYTEMS OF HYBRID AND ELECTRIC VEHICLES

Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles. Steering and Suspension system. Choice of Tires.

Text Books:

1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2005.

Reference Books:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley & Sons,2003
2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005
3. Ron Hod Kinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand working of different configurations of hybrid and electric vehicles	L3
CO2	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.	L2
CO3	Choose proper energy storage systems for vehicle applications	L2
CO4	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources	L3
CO5	Understand basic operation of power-split device in hybrid electric vehicle	L2

III Year II Semester	METAL FORMING & PRESS WORKING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The course's goal is to:

- Gain the fundamental knowledge about metal forming and metal joining processes.
- Understand the analysis of flow of material and its properties during the processes.
- Selection the process of metal forming as application.
- Introduce the theory and practices of metal forming and press working processes.
- Develop the analytical relation between input and output parameters of process.

UNIT – I:

Introduction: Principle of plastic deformation and yield criteria, Recrystallization, Fundamentals of hot and cold Working processes, advantages and disadvantages; Effect of strain rate on forming process. Methods of metal forming processes, advantages, disadvantages and application.

UNIT – II:

Forging: Classification of forging, closed die forging, Open die forging, drop forging, Machine forging, Load estimation in forging, analysis of forging: sticking friction model, sliding friction model, pre forming operations: Fullering, Drawing, Offsetting, Edging, Flattening, Chamfering, Bending, Swaging, Finishing, Trimming, Defects in forging.

Rolling: Assumptions, Neutral point, deformation angle, Principle of rolling, Rolling stand arrangement, Rolling load calculation, Power required for rolling, Roll passes, Flat rolling, Pipe rolling, Defects in rolled products.

UNIT – III:

Extrusion: Extrusion types, Forward, backward extrusion, Hydrostatic Extrusion, Impact Extrusion, Calculation of force in extrusion, Load estimation in extrusion, Extrusion of tubes, Defects in Extrusion.

Drawing: Wire drawing, Different types of lubricant condition, Drawing load and force calculation, Tube drawing, Types of mandrel, Drawing defects.

UNIT – IV:

Sheet Metal Forming: Sheet metal working-shearing, Major operation, Minor operation, Mechanism of Blanking, Piercing, Load estimation in blanking and piercing, Methods of reducing shear force, Deep Drawing Operation, Design of blank, Load required, Blank holder force, stresses induced, Draw ratio method, Defects in deep drawing operation.

Bending: Principle of bending, Types of bending, Spring back effect.

UNIT – V:

Press Working Fundamentals, Operations, and Machinery: Shearing Theory-Critical stages of shearing, features of a punched hole, slug, burr. Clearance typesand their effects, Clearance for blanking and Piercing, Cutting Force – Methods to reduce cutting force, stripping force.

Presses: Common types of Presses, Main parts of a typical power press, Specification of presses, Comparison of Mechanical, hydraulic and Pneumatic presses. Single action, double action and triple action presses. Press operating parameters – Special purpose presses – Press brake, transfer press, multi slide machine – Press Feeding Mechanisms – Ejection Mechanism.

TEXTBOOKS:

1. Manufacturing Technology, P. N. Rao, Vol. 3, 3rdEdition, TMH Publication
2. Manufacturing Engineering and Technology, S. Kalpakjian, S. Schimid, Pearson Publication.
3. "Techniques of Press working sheet metal",Donald F. Eary. & Edward A. Reed, Prentice-Hall,Inc.,

REFERENCE BOOKS:

1. Mechanical metallurgy by G. W Dieter
2. American Society of Metals – Hand book – Volume 4 (Forming)

Course Outcomes: At the end of the course students will be able to

CO's	Statements	Bloom's Level
CO1	Understand the fundamentals of hot and cold Working processes.	L2
CO2	Learn Forging and Rolling Processes	L3
CO3	Understand different Extrusion and Drawing Processes and their applications.	L3
CO4	Understand the Mechanisms of Sheet metal forming, bending and press working	L2

III Year II Semester	BATTERY TECHNOLOGY	L	T	P	C
		3	0	0	3

Unit I:
Introduction
Energy Storage Applications and Electric Vehicles, different Batteries -Lead-acid, Nickel-Metal Hydride, Nickel-Cadmium and lithium-ion. cell requirements and specifications

Unit II:
Battery Characteristics
Cell Voltage under load, Charge and Discharge Rates, Capacity, Impedance, Specific Energy and Power, Efficiency, cycle life, self-discharge and Ragone Plot, Capacity and Pulse Power Testing, Electrochemical Impedance Spectroscopy Testing

Unit III:
Lithium-ion Battery
Battery Materials and their characteristics, Electrochemical Cell and Governing Equations, Electrode Kinetics, Thermodynamics, Solid Phase and Electrolyte Phase, Practical cell measurement – Cell Voltage, Capacity Energy and Power, Cell Formats.

Unit IV:
Battery Balancing methods
Need for balancing, Active methods – cell bypass, cell to cell, cell to pack, pack to celland passive methods - fixed shunt resistor, switched shuntresistor and switched transistor

Unit V:
Battery Management Systems
Thermal Management: Heating and cooling needs, Influence of battery temperature on battery performance, thermal management methods – air cooling, cooling by dielectric oil and cooling by liquid.
Cell Management: Functionality, technology and topology - centralized, modular, master-slave, distributed, Intelligent cell monitoring,

Text Books:

1. H. J. Bergveld, W. S. Kruijt, and P. H. Notten, “Battery Management Systems: Design by Modelling,” Kluwer Academic Publisher, 2002
2. C. Rahn, C.Y. Wang, Battery systems engineering, John Wiley & Sons, 2013
3. John G. Hayes and G. Abas Goodarzi,“Electric Powertrain - Energy Systems, Power
4. Electronics and Drives for Hybrid,Electric and Fuel Cell Vehicles”, Wiley 2018
5. James Larminie and John Lowry, “Electric Vehicle Technology Explained, John Wiley and Sons, 2003

III Year II Semester	MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems**.**

UNIT I:

LEARNING PROBLEMS AND ALGORITHMS:

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II:

NEURAL NETWORKS:

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning

UNIT III:

MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS:

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering

UNIT IV:

DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS:

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs**.**

UNIT V:

DEEP LEARNING: RNNS, AUTOENCODERS AND GANS:

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, **Autoencoders**: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

Reference Books:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

Course Outcomes: At the end of the course the student will be able to

CO's	Statements	Bloom's Level
CO1	Illustrate the categorization of machine learning algorithms.	L4
CO2	Compare and contrast the types of neural network architectures, activation functions	L3
CO3	Acquaint with the pattern association using neural networks	L3
CO4	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks	L2

III Year II Semester	CONDITIONING MONITORING	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.
- To implement the basic signal processing techniques.
- To understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
- To understand the significance of mechanical fault diagnosis and non-destructive testing techniques in monitoring and maintenance.
- To study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.

UNIT – I

Introduction to maintenance and condition based maintenance, Definition, system approach, objectives, responsibilities of maintenance department, maintenance strategies, principles of maintenance, concepts of maintainability, availability and reliability, implementation of CBM, comparison of CBM with other maintenance techniques and case studies (overview). Introduction to condition monitoring, basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring.

UNIT – II

Basic signal processing techniques Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis. Wavelet Transform Introduction to Wavelets, Continuous Wavelet Transform (CWT), Discrete Wavelet Transform (DWT), Wavelet Packet Transform (WPT),types of wavelets –Haar wavelets, Shannon wavelets, Meyer wavelets, Daubechies wavelets, Coifman wavelets and applications of wavelets.

UNIT – III

Vibration Monitoring, Introduction, vibration data collection, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration analysis.

Rotating and reciprocating machines, Vibration signals from rotating and reciprocating machines – signal classification, signals, generated by rotating machines, signals generated by reciprocating machines.

UNIT – IV

Mechanical fault diagnosis, Wear monitoring and lubricant analysis - sources of contamination, techniques, Spectrometric, Oil Analysis Procedure (SOAP) and ferrography. Non-destructive testing techniques, Measurement of surface and subsurface flaws – liquid penetrant inspection, eddy current inspection, radiographic inspection, ultrasonic inspection.

UNIT – V

Condition monitoring of rolling element bearings and gear, Introduction, construction, types of faults, rolling element bearing diagnostics and gear diagnostics. Tool wear monitoring, Introduction, techniques and case studies.

TEXT BOOKS:

1. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
2. R.A.Collacot – Mechanical Fault Diagnosis – Chapman and Hall Ltd., 1977.
3. R.C.Mishra, K.Pathak – Maintenance Engineering and Management, Prentice Hall of India Pvt. Ltd., 2002.
4. K. P. Soman, K. I. Ramachandran, N. G. Resmi – Insight into wavelet from theory to practice, Third Edition, Prentice Hall of India,

REFERENCES BOOKS:

1. John S.Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books,1993.
2. “Hand book of Condition Monitoring” ELSEVIER SCIENCE
3. R. A. Collacott, “Vibration monitoring and diagnosis”, Wiley,1979.
4. Rao J.S. “Vibratory Condition Monitoring of Machines ”, CRC Press,2000.
5. “Condition Monitoring manual”, National Productivity Council, New Delhi.

Course Outcomes: At the end of this course the student shall be able to:

CO’s	Statements	Bloom’s Level
CO1	Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.	L4
CO2	Implement the basic signal processing techniques.	L3
CO3	Understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.	L3
CO4	Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.	L2
CO5	Study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.	L2

III Year II Semester	ENGINE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of the Spark Ignition and compression ignition engine management systems, engine diagnostics procedure, Computerised electronic fuel injection systems and air flow fuel management strategies.

UNIT-I

Computerized Electronic Fuel Injection: Engine Input Sensors Coolant & Intake Temperature, Crankshaft Position, Camshaft Position, Manifold Absolute Pressure, Throttle Position, Oxygen, Air/Fuel Ratio, Knock Speed& Distance, Battery & Switches Output Devices -Relays, Injector Sequencing & Management, Ignition Operation, Idle Air Control, EGR, EVAP, Waste gate Solenoids, Torque Converter & Speed Control, Malfunction Indicator Light

UNIT -II

Speed Density/Mass Air Flow Fuel Management Strategies: Key ON Mode, Crank Mode, Open & Closed Loop, Wide-Open Throttle, Adaptive Memory Cells, Cruise &Deceleration, Wide-Open Throttle, Key OFF Mode Fuel Injection Systems -Electronic Fuel Systems, Computer Self-Diagnostic Circuits, Electronic Throttle Actuator Control Systems, Fuel Control, Fuel Supply System Control, Injection System Inspection and Maintenance.

UNIT -III

Engine Diagnostic Procedures Fuel System testing, On Board Diagnostics, Monitored &Non Monitored Circuits, Diagnostic Trouble Codes, Digital Engine Control System: Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.

UNIT -IV

SI Engine Management: Feedback carburettor system, throttle body injection, multi-point fuel injection and direct injection systems, Layout and working of SI engine management systems like Bosch Mono-jetronic, L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control. Three-way catalytic converter, conversion efficiency versus lambda.

UNIT – V

CI Engine Management: Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection

system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems.

TEXT BOOKS:

1. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004

2. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

REFERENCE BOOKS:

1.Halderman, J. & Linder, J. (2012). Automotive Fuel and Emissions Control Systems (3rd Edition)Upper Saddle River, NJ: Pearson Education.

2.Halderman, J. D. (2011). Diagnosis &Troubleshooting of Automotive Electrical, Electronic, &Computer Systems (6th Edition) Upper Saddle River, NJ: Pearson Education.

3. Understanding Automotive Electronics – Bechfold SAE 1998

4. Automobile Electronics by Eric Chowanietz SAE

5. Fundamentals of Automotive Electronics - V.A.W.Hilliers - Hatchin, London

6.Automobile Electrical & Electronic Equipment (2000) Young, Griffitns - Butterworths, London.

7.Understanding Automotive Electronics, William B. Ribbens, 5th Edition, Newnes, Butterworth– Heinemann, 2001.

8.Automotive Computers & Digital Instrumentation – Robert N. Brandy, Prentice Hall, 2004

9.The Fundamentals of Electrical Systems - John Hartly - Longman Scientific & Technical, 2002.

Course Outcomes: After the completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Acquire the knowledge about Computerized Electronic Fuel Injection, Battery & Switches Output Devices	L4
CO2	Understand the Air Flow Fuel Management Strategies and electronic fuel systems.	L3
CO3	Describe the Engine Diagnostic Procedures Fuel System testing.	L3
CO4	Analyze the spark ignition and compression ignition management systems.	L2

III Year-II Semester	CFD FOR AUTOMOBILE APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

- To get Familiarize with the governing equations in CFD and its application areas
- To Understand Elliptic, Parabolic and Hyperbolic partial differential equations and solve the linear equations.
- To Analyse the CFD problem by Finite difference and Finite volume methods and apply different computational Techniques.

UNIT-I

Introduction: Philosophy of Computational Fluid Dynamics (CFD), Impact of CFD and its use as research and design tool. Application areas: Automobile & Engine, Civil engineering, Environmental, Naval Architecture.

Governing Equations of fluid dynamics: Derivation, discussion of their physical meaning, models of the flow, substantial derivative, Divergence of a velocity, Navier-Stokes Equation, Physical boundary conditions, Forms of governing equation suited to CFD

UNIT-II

Mathematical behavior of Partial Differential Equations: Classification of Quasi-Linear PDE, The Eigenvalue Method, Hyperbolic, parabolic & Elliptic equations.

Solution of System of Linear Equations: Algorithms for the solution of linear problems; awareness of typical applications for such software and practical issues associated with implementation. Efficient direct and iterative solution algorithms for large, sparse, linear equation systems.

UNIT-III

Finite difference discretization: Basic aspects of discretization, finite difference method, difference equations, Polynomial Approach; Explicit and Implicit schemes, stability analysis; Grid transformations, transformation of equations

Basic Computational Techniques: Lax-Wendroff Technique, Mac Cormack's Technique, Space Marching, Relaxation Technique, Alternating direction implicit method.

UNIT-IV

Basics of Finite Volume Methods: Finite volume discretization, Approximation of Surface Integrals, Approximation of Volume Integrals, Interpolation schemes, Upwind Interpolation, Linear Interpolation, Quadratic Upwind Interpolation, and Higher-Order Schemes.

Applications of Finite Volume Methods: One-dimensional steady state diffusion, Steady one-dimensional convection and diffusion, Assessment of the central differencing scheme for convection-diffusion problemsand TDMA algorithm.

UNIT-V

Introduction to finite element method: Basics of finite element method, stiffness matrix, Iso-parametric elements, Formulation of finite elements for one dimensional flow and heat transfer problems.

CFD applied to Automobiles: Introduction of automobile parts and its aerodynamics design analysis. Advantages of the CFD used in automobile. Case studies.

Text Books:

1. Computational Fluid Dynamics the Basics with Applications, John D Anderson, Jr., McGraw Hill Book Company.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H K Versteeg, W Malalasekera, Pearson Education Ltd

References:

1. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing Co.
2. Fundamentals of Computational Fluid Dynamics, Tapan K. Sengupta, Universities Press.
3. Computational Method for Fluid Dynamics, Joel H. Ferziger and Milovan Peric, 3rd Edition, Springer, 2002.
4. Computational Fluid Mechanics and Heat Transfer, Dale A. Anderson, John C. Tannehill and Richard H. Pletcher,2nd Edition, Taylor and Francis, 1984.

Course Outcomes: After the completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Familiarize with the governing equations in CFD and its application areas	L4
CO2	Understand Elliptic, Parabolic and Hyperbolic partial differential equations and solve the linear equations.	L3
CO3	Analyse the CFD problem by Finite difference method and apply different computational Techniques.	L3
CO4	Analyse the CFD problem by Finite volume method and understand different applications	L2
CO5	Familiarize with finite element method and applications of CFD in the design of automobiles.	L2

III Year II Semester	MODELING AND SIMULATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: The course's goal is to:

- Learn way of analysing the systems.
- Classification of systems based nature of dynamics and knowledge of elements.
- Develop simulation model for dynamic discrete – event stochastic system.
- Run the model and collect the data.
- Analyse the output data of simulation for specified for performance measures bases on type of simulation and method of output data analysis.

UNIT – I:

System – ways to analyse the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors – Framing – strong law of large numbers.

UNIT – II:

Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modelling – Techniques for verification – statistical procedures for developing credible model. Modelling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modelling.

UNIT – III:

Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – Weibull – normal Bernoulli – Binomial – uniform – poison. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.

UNIT – IV:

Output data analysis – Types of Simulation with respect to output data analysis – warm up period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons.

UNIT – V:

Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – New boy paper

problem.

TEXTBOOKS:

1. Simulation Modelling and Analysis by Law, A.M. & Kelton, McGraw Hill, 2nd Edition, New York, 1991.
2. Discrete Event System Simulation by Banks J. & Carson J.S., PH, Englewood Cliffs, NJ, 1984

REFERENCE BOOKS:

1. Simulation of Manufacturing Systems by Carrie A., Wiley, NY, 1990.
2. A Course in Simulation by Ross, S.M., McMillan, NY, 1990.
3. Simulation Modelling and SIMNET by Taha H.A., PH, Englewood Cliffs, NJ, 1987.)

Course Outcomes: On the completion of the course the student will able to

CO's	Statements	Bloom's Level
CO1	Understand different Simulation models and different steps in simulation.	L1
CO2	Understand the Generation of random variates and its factors for selection	L2
CO3	Compare the different simulation languages with general purpose languages and differentiate Simulation languages vs Simulators.	L2
CO4	Understand the different types of simulation with respect to output data analysis.	L2

III Year II Semester	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives: Course Objectives: The course should enable the students to understand the Lean and factory simulation, and comparison of Lean manufacturing with other methods. The student also should understand the tools of Lean manufacturing, Value Stream mapping and best practices in Lean manufacturing.

Unit I
Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods – The 7 Wastes, their causes and the effects – An overview of Lean Principles / concepts / tools – Stockless Production.

UNIT-II
The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow – 5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems, Ford production systems

Unit- III
Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map – Building a Current State Map (principles, concepts, loops, and methodology) – Application to the factory Simulation scenario.

Unit – IV
Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completed Future State Maps – Application to factory simulation – Implementation of lean practices – Best Practices in Lean Manufacturing.

UNIT-V
TQM Tools and Techniques:
The seven traditional tools of quality, new management tools, and six sigma: Concepts, methodology, applications to manufacturing, service sector including IT, Bench marking, Reason to bench mark, Bench marking process, FMEA, Stages, and Types. Quality circles, Quality Function Deployment (QFD), Taguchi quality loss function, TPM, Concepts, improvement needs, Cost of Quality, Performance measures

Text Books:

1. Womack J. P., Jones D.T. and Roos D. – 'The Machine that Changed the World: the Story of Lean Production' – Simon & Schuster, New York – 1996
2. Liker J. K. – 'Becoming Lean' – Industrial Engineering and Management Press – 1998
3. Womack J. P. and Jones D. T. – 'Lean Thinking' – Simon & Schuster, USA – 1996
4. Rother M. and Shook J. – 'Learning to See' – The Lean Enterprise Institute, Brookline, USA – 2003

Course Outcomes: After the completion of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Understand the basics of Lean manufacturing and comparison with other methods of manufacturing	L1
CO2	Understand the tools used in Lean Manufacturing and total predictive maintenance	L2
CO3	Appreciate the value stream mapping and Application to the factory Simulation scenario.	L2

III B.Tech II Semester	AUTOMOBILE HVAC	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

Students undergoing this course are expected

1. To provide introduction to students the fundamentals of refrigerant, refrigeration systems and air conditioning controls to automobile applications.
2. To teach students the principle of psychometry.
3. To enable the students to understand heating and cooling load calculations.
4. To develop the knowledge about air distribution systems.
5. To introduces the general servicing of automotive air conditioning systems.

UNIT I:

REFRIGERATION

Introduction - Methods of Refrigeration - Air Refrigeration System and its Applications - Vapour Compression Refrigeration System - Vapor Absorption Refrigeration System - Applications of Refrigeration & Air Conditioning - Automobile Air Conditioning - Air Conditioning for Passengers, Isolated Vehicles and Transport Vehicles - Applications Related with Very Low Temperatures. Classification, Properties and Selection Criteria - Commonly Used Refrigerants - Alternative Refrigerants - Eco-Friendly Refrigerants - Applications of Refrigerants - Refrigerants Used in Automobile Air Conditioning

UNIT II:

PSYCHOMETRY

Psychometric Properties, Tables, Charts - Psychometric Processes - Comfort Charts - Factors Affecting Comfort - Effective Temperature - Ventilation Requirements.

UNIT III

AIR CONDITIONING SYSTEMS AND LOAD ANALYSIS

Classification and Layouts - Central / Unitary Air Conditioning Systems - Components Like Compressors, Evaporators, Condensers, Expansion Devices, Fan Blowers, Heating Systems Etc. Load Analysis - Outside & Inside Design Consideration - Factors Forming the Load on Refrigeration & Air Conditioning Systems - Cooling & Heating Load Calculations - Load Calculations for Automobiles - Effect of Air Conditioning Load on Engine Performance.

UNIT IV:

AIR DISTRIBUTION SYSTEMS

Distribution Duct System, Sizing, Supply / Return Ducts - Types of Grills, Diffusers, Ventilation, Air Noise Level - Layout of Duct Systems for Automobiles and their Impact on Load Calculations. Air Routine & Temperature Control - Objectives - Evaporator Care Air Flow - Through the Dash Recirculating Unit - Automatic Temperature Control - Controlling Flow - Control of Air Handling Systems.

UNIT V:

AIR CONDITIONING SERVICE AND CONTROL

Air Conditioner Maintenance & Service - Servicing Heater System - Removing & Replacing Components - Trouble Shooting of Air Conditioning System -Compressor Service, Methods of Dehydration, Charging & Testing. Air Conditioning Control - Common Control Such as Thermostats- Humidistat Us - Control Dampers - Pressure Cutouts and Relays

COURSE OUTCOMES: Attending the laboratory the students shall be able to:

CO's	Statements	Bloom's Level
CO1	Understand the different Air refirgerations systems and their applications.	L2
CO2	learn Psychrometry properties and ventilation requirements.	L3
CO3	Understand Air-Conditioning systems and load analysis	L2
CO4	Learn Air-Conditioning Service and Control	L3

III B.Tech II Semester	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

UNIT I:

INTRODUCTION TO MEASUREMENTS AND SENSORS:

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error Propagation of error- Odds and uncertainty- principle of transduction- Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers Dynamic characteristics of first and second order transducers for standard test inputs

UNIT II:

VARIABLE RESISTANCE AND INDUTANCE SENSORS:

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT.

UNIT III:

VARIABLE AND OTHER SPECIAL SENSORS:

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers- Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT IV:

AUTOMOTIVE ACTUATORS:

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

UNIT V:

AUTOMATIC TEMPERATURE CONTROL ACTUATORS:

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

TEXT BOOKS:

1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. DoebelinDhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

REFERENCES:

1. James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, " Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

COURSE OUTCOMES: At the end of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	List common types of sensor and actuators used in vehicles.	L2
CO2	Design measuring equipment's for the measurement of pressure force, temperature and flow.	L3
CO3	Generate new ideas in designing the sensors and actuators for automotive application	L3
CO4	Understand the operation of the sensors, actuators and electronic control.	L2

III B.Tech II Semester	TWO & THREE WHEELERS	L	T	P	C
		3	0	0	3

Course Objectives:
The objective of this course is to make the students to know and understand the constructional details, operating characteristics and design aspects of Two and Three wheelers.

UNIT I INTRODUCTION
Classifications- design considerations –weight and dimension limitations – requirements, stability problems, gyroscopic effect- pendulum effect of two and three wheelers.

UNIT II POWER UNITS, IGNITION SYSTEMS ELECTRICAL &BRAKING SYSTEMS
2 stoke and 4 stoke engines. Design criteria for engines – design of cylinders, cylinder head, cooling fins, crank case, connecting rod and crank shaft. Carburetor types. Wiring layout for two wheelers. Braking system in two wheelers, Fundamentals of EFI.

UNIT III CLUTCHES AND TRANSMISSION
Types of clutches. Design of clutch system. Gears for two and three wheelers. Design of gear box and gear change mechanism. Belt, chain and shaft drive. Freewheeling devices, starting systems.

UNIT IV FRAMES, SUSPENSION, WHEELS AND TYRES
Types of frames. Wheel frames- construction design of frames for fatigue strength, torsional stiffness and lateral stability. Front and rear forks. Springs for suspension, Dampers, constructional details of wheel and tyres.

UNIT V THREE WHEELERS
Auto rickshaws - Pick-Ups and delivery type vehicle, frames and transmission, wheel types, wheel mountings attachment, tyre types. Brake systems.

REFERENCES
1. ‘Cycle Motor Manual’, Templeton Press Ltd., London, 1992.
2. Irving P.E., “Motor Cycle Engineering”, Temple Press Book, London, 1964
3. Johns.B.A., ‘Motorcycles’, Good Heart will, 1984.
4. M.M.Griffin., ‘Motor cycles from inside and outside’, Prentice Hall Inc, New Jersey, 1978.
5. Marshal Cavandedish, ‘Encyclopedia of Motor cycling’, New York, 1989
6. Servicing Manuals- various motor cycles, Scooters, Mopeds and three wheelers.
7. Srinivasan.S., ‘Motor cycle, Scooter, Mopeds’, New century book house, 1988

Course Outcomes:

Students will have the basic knowledge on various two wheelers and its technology along with its functions. At the end of the course the students will have thorough knowledge over different frames, suspension system and transmission unit used on various two and three wheeler vehicles.

III B.Tech II Semester	HYBRID AND EV TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives: The course should enable the students to:

- General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
- Understand about vehicle dynamics,
- Design the required energy storage devices,
- Select the suitable electric propulsion systems and understand the hybrid electric vehicles.

UNIT I
INTRODUCTION
Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT II
DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES
Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT III
ENERGY SOURCES
Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery charging- Quick Charging devices. Battery Management System.
Polymer Exchange Membrane Fuel Cell- Characteristics- Half reactions of fuel cell. Cells in series and parallel- water management - Thermal Management.

UNIT IV
MOTORS
Characteristics of DC motors (Brush and Brushless), AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/AC converters.

UNIT V
SUBSYSTEMS OF HYBRID AND ELECTRIC VEHICLES
Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle- Economy of hybrid Vehicles. Choice of Tires.

TEXT BOOKS:

1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2003
2. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005.

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley &Sons,2003
2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005
3. Ron Hokinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth HeinemannPublication,2005

COURSE OUTCOMES: At the end of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Explain the Electric and hybrid vehicle operation and architectures	L2
CO2	Design of hybrid and electric vehicles.	L3
CO3	Understand the Energy requirement for vehicles.	L3
CO4	Learn the Vehicle characteristics, operating modes, and performance parameters of the vehicle	L2

III Year-II Semester	ALTERNATIVE FUELS FOR IC ENGINES	L 3	T 0	P 0	C 3

Course Objectives: To impart the necessity of finding alternative energy sources for automobiles. To understand merits and demerits, performance characteristics of various sources of fuels and their comparison.

UNIT I CONVENTIONAL FUELS FOR I.C. ENGINES

Petroleum based conventional fuels for SI and CI engine, Demand and Availability of crude oil – vehicle population increase – national and international standards for conventional and alternative fuels.

Desirable characteristics of SI Engine fuels – Petrol – Properties, Specification, chemical structure, Volatility characteristics, knock rating and additives. Desirable characteristics of CI Engine fuels – Diesel – Properties, Specification, chemical structure, Ignition quality, Cetane rating and additives.

UNIT II ALCOHOLS AS FUELS

Availability of different alternative fuels for engines. Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of alcohol fuels

UNIT III VEGETABLE OILS AND BIODIESEL AS FUELS

Properties of Vegetable oils and biodiesel- Methods of using vegetable oils – Blending, preheating, and emulsification – Preparation of biodiesel from non-edible, edible oil and Algae - Performance, combustion and emission Characteristics in diesel engines. Advantages and disadvantages of Vegetable oils and biodiesel

UNIT IV HYDROGEN AS FUEL

Hydrogen – Properties, Production methods, storage and safety aspects. Issues & limitation in Hydrogen. Methods of using hydrogen in engines. Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Hydrogen fuel.

UNIT V BIOGAS, CNG AND LPG AS FUELS

Biogas, Compressed Natural gas (CNG) and LPG – Properties and production methods. CO2 and H2S scrubbing in Biogas, Modifications required for use in Engines- Performance, combustion and emission Characteristics in engines. Advantages and disadvantages of Gaseous fuels. Working of LPG and CNG kits used in automotive engines.

REFERENCES

1. Arumugam S. Ramadhas, “Alternative Fuels for Transportation” CRC Press, 2011.
2. Ayhan Demirbas and M. Fatih Demirbas, “Algae Energy-Algae as a New Source of Biodiesel”, Springer-Verlag London Limited 2010.

3. Ayhan Demirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer-Verlag London Limited 2008
4. David M. Mousdale, "Introduction to Biofuels", CRC Press, 2015.
5. Ganesan.V., "Internal Combustion Engineering", Tata McGraw-Hill Publishing Co., New Delhi, 2003.
6. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
7. M. K. Gajendra Babu and K. A. Subramanian, "Alternative Transportation Fuels-Utilisation in Combustion Engines", CRC Press, 2013.
8. M.L. Mathur, R.P.Sharma "Internal combustion engines", Dhanpatrai publication, 2003.
9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

COURSE OUTCOMES: At the end of the course, the student will be able to

CO's	Statements	Bloom's Level
CO1	Possess a comprehensive understanding of available alternative fuels for IC engines. They will possess complete knowledge on producing different biofuels, modifying them and using them in IC engines	L2
CO2	Acquire the skills in developing new technologies for alternative fuels efficiently in IC engines.	L3
CO3	Demonstrate the importance of using alternative fuels for sustainable energy supply and for emission control in IC engines.	L3

III Year-II Semester	VEHICLE EVALUATION LAB	L	T	P	C
		0	0	3	1.5

(Minimum 6 Experiments)
(Demonstration of these standards for the identified tests also permitted)

1. Brake Performance Evaluation for 4 -Wheelers (as per IS 11852-2001, Part 1 to 8, and IS 11852-2003, Part 9) Brake Performance
2. Pass-by Noise Level Measurement Test for all vehicles (as per IS 3028-1998)
3. Interior Noise Level Measurement Test for N2 / N3 and M2 / M3 category of vehicles (as per AIS 020)
4. Turning Circle Diameter Check for all vehicles other than 2- Wheelers (as per IS 12222-2011)
5. Steering Effort Measurement for all vehicles other than 2- Wheelers (as per IS 11948-1998)
6. Hood Latch Test (for all four wheelers fitted with a front bonnet) (as per IS 14226-1995)
7. Stationary Noise Level Measurement (as per ISO 5130:1982(E), IS 10399:1998 for all vehicles
8. Tell Tale Symbols Checks (as per AIS: 071-2009)
9. Range Test for LPG / CNG fuelled vehicles (as per AIS 055) Physical Verification Tests for All type of vehicles (as per CMVR)
10. Vehicle Weighment for all vehicles (as per IS 11825-1986) Wheel Guard Measurement for Passenger Cars (as per IS 13943-1994)
11. Safety Checks for CNG / LPG fuelled vehicles (as per AIS 026, AIS 027 and AIS 028)
12. Acceleration performance of 2 wheeler (as per IS 10407: 1998)
13. Acceleration performance of automotive vehicles other than 2 & 3 wheelers (as per IS 11851:1986)
14. Fuel efficiency test Highway fuel consumption City fuel consumption
15. Manoeuvrability on Serpentine Course
16. Bus body code as per AIS:052
17. Truck code as per AIS:093
18. Ambulance code as per AIS:125
19. School Bus as per AIS:063
20. Sleeper Coach as per AIS:119
21. Double Decker Buses as per AIS:139

Note: 1. The institute must have tie-up with any two/three/four wheeler workshop to carryout certain tests
2. The institute must have standard two/three/four wheeler chassis dynamometer

III Year-II Semester	VEHICLE MAINTENANCE LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To study the various maintenance, the reconditioning of vehicle parts.
- To train the structures in identifying the fault and rectification.
- To impart the fundamental knowledge in evaluation and maintenance.
- To know about the various methods of maintaining vehicles and their subsystems.

STUDY EXPERIMENTS: (Atleast 3 of 6 experiments)

1. Study and layout of an automobile repair, service and maintenance shop.
2. Safety aspects with respect to man, machine and tools.
3. General procedures for servicing and maintenance schedule.
4. Fault diagnosis and service of transmission system
5. Fault diagnosis and service of Electrical system like battery, starting system, charging system, lighting system etc.
6. Fault diagnosis and service of vehicle air conditioning system

LIST OF EXPERIMENTS (Atleast 8 of 10 experiements)

1. Minor and major tune up of gasoline and diesel engines.
2. Calibration of Fuel injection pump.
3. Calibration of fuel injection nozzle and tester
4. Removal and fitting of tire and tube.
5. Fault diagnosis of ignition system and spark plug cleaner & tester
6. Adjustment of pedal play in clutch, brake, hand brake lever and steering wheel.
7. Wheel alignment procedure for servicing and maintenance.
8. Fault diagnosis of brake/clutch
9. Calibration of head lamp aligner
10. Calibration of Re-facer of valve.

Course Outcomes: At the completion of the course, the student should be able to

- Understand the various maintenance the reconditioning of vehicle parts.
- Analyse the structures in identifying the fault and rectification.
- Acquire the fundamental knowledge in evaluation and maintenance.
- Understand the various methods of maintaining vehicles and their subsystems.

III Year-II Semester	AUTOMOBILE ECU SENSORS AND ACTUATORS LAB	L	T	P	C
		0	0	3	1.5

1. NI cDAQ-9178 (DAQ System with Analog/Digital I/O)

- **Exp 1:**
  Conduct an experiment to monitor and control real-time data from multiple sensors using the NI cDAQ-9178 system.
- **Exp 2:**
  Perform analog signal acquisition and generate corresponding digital output control for a basic mechatronic application using NI cDAQ-9178.

2. NI myRIO-1900 (with Encoder, IR, Ultrasonic, Servo Motor)

- **Exp 3:**
  Implement closed-loop control to maintain the speed and position of a servo motor using encoder feedback on NI myRIO.
- **Exp 4:**
  Design and test an obstacle detection system using ultrasonic and infrared sensors interfaced with NI myRIO.

3. Transducer Trainer Kit (Loadcell, LVDT, Pressure, IR, Ultrasonic)

- **Exp 5:**
  Conduct an experiment to measure and calibrate force using a load cell and appropriate signal conditioning circuitry.
- **Exp 6:**
  Determine the linear displacement of a moving object using an LVDT sensor and analyze the processed signal.

4. Siemens S7-1500 PLC with CIROS Software

- **Exp 7:**
  Simulate and program a conveyor-based sorting system using Siemens S7-1500 PLC and CIROS software.
- **Exp 8:**
  Design and simulate an automated bottle filling and capping process using ladder logic programming in CIROS with Siemens PLC.

5. ARB Waveform Generator

- **Exp 9:**
  Generate custom electrical signals using the ARB function generator and analyze their characteristics using an oscilloscope.
- **Exp 10:**
  Test and evaluate the response of sensors to arbitrary excitation signals produced by the ARB waveform generator

MINORS	BASIC AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

The course imparts the principles of automobile systems and provides the salient features of safety, emission and service of automobiles.

UNIT – I:

Engines – Classification

INTRODUCTION: Components of four wheeler automobile – chassis and body – power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation

UNIT – II:

TRANSMISSION SYSTEM: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. propeller shaft – Hotchkiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres.

UNIT – III:

STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toe-in, center point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

UNIT – IV:

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

BRAKING SYSTEM: Mechanical brake system, hydraulic brake system, master cylinder, and wheel cylinder tandem master cylinder requirement of brake fluid, pneumatic and vacuum brakes.

ELECTRICAL SYSTEM: Charging circuit, generator, current – voltage regulator – starting system, Bendix drive mechanism solenoid switch, lighting systems, horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator.

UNIT – V:

ENGINE SPECIFICATIONS AND SAFETY SYSTEMS: Introduction- engine specifications with regard to power, speed, torque, cylinder arrangement, lubrication and cooling.

Safety: Introduction, safety systems - seat belt, air bags, bumper, anti-lock brake system (ABS), Suspension sensors, traction control, central locking and electric windows, speed control.

TEXT BOOKS:

1. Automotive Mechanics – Vol. 1 & Vol. 2 / Kirpal Singh/standard publishers

2. Automobile Engineering / William Crouse/TMH Distributors

3. Automobile Engineering/P.S Gill/S.K. Kataria & Sons/New Delhi.

REFERENCES:

1. Automotive Engines Theory and Servicing/James D. Halderman and Chase D. Mitchell Jr., / Pearson education Inc.

2. Automotive Engineering / K Newton, W.Steeds& TK Garrett/SAE

3. Automotive Mechanics : Principles and Practices/ Joseph Heitner/Van Nostrand Reinhold

4. Automobile Engineering / C Srinivasan/McGraw-Hill.

Course Outcomes:

The student after undergoing the course, shall learn about transmission, steering, suspension, braking and safety and should know the vehicle troubleshooting**.**

		L	T	P	C
MINORS	**IC ENGINES**	**3**	**0**	**0**	**3**

Course Objectives:

- To impart the knowledge and providing holistic view on IC Engines and its developments
- To enable the students to calculate the performance and testing of IC engines
- To fetch with SI & CI fuelling system and combustion behaviour and its advancements to meet the stringent emission norms
- Understanding the formation and control strategies of SI and CI Engine emissions

UNIT-I:

Engine Principles: Introduction, Comparison of Air Standard and Actual Cycles, Constructional Details of Four Stroke SI and CI Engines, Working Principle, Actual Indicator Diagram, Two Stroke Engine Construction and Operation, Comparison of Four Stroke and Two Stroke Engine Operation, Firing Order and Its Significance.

UNIT-II:

ENGINE TESTING & PERFORMANCE

Engine Performance Testing & Numerical- methods and Performance Characteristics; Performance Maps. Lubrication and Cooling systems, Introduction to Supercharging and Turbocharging; Introduction to Engine Cooling and Lubrication

UNIT-III:

SI ENGINE COMBUSTION

Carburettor Working Principle, Requirements of an Automotive Carburettor, and types, Fuel Injection Systems; Pre-mixed charge combustion, SI Engine Combustion Conceptual models, Knocking Combustion

UNIT-IV:

CI ENGINE COMBUSTION

Fuel Injection and Spray Structure: Fuel Atomization. Diesel Combustion Process Characterization: Ignition Delay, Effect of Engine and Operational Parameters on Delay, Pre-mixed Combustion and Mixing Controlled Combustion.

UNIT-V:

ADVANCED COMBUSTION MODES

GDI, Flexi Fuel, CAI, Introduction to Low Temperature Combustion Like: Homogeneous Charge Compression Ignition(HCCI), Fuel Stratified Charge combustion/ Reactivity Controlled Compression Ignition (RCCI) and Pre-mixed Charge Compression (PCCI) technologies.

Text Books:

1. IC Engines, M.L. Mathur & R.P. Sharma, Dhanpath Rai & Sons
2. Engine Emissions, Pollutant Formation and Advances in Control Technology, B.P. Pundir, Narosa Publishing House

Reference Books:

1. IC Engines Fundamentals, John B. Heywood, Mc Graw Hill Publications
2. Engineering Fundamentals of I C Engines, WiliardW.Pulkrabek, Prentice Hall Publications

Course Outcomes: At the end of the course, the students should be able to

- Differentiate the ideal, air standard cycles and actual thermodynamic cycles.
- Evaluate the Engine performance based on the experimental data
- Analyse the fueling system and combustion behaviour of SI engine
- Analyse the fueling system and combustion behaviour of CI engine
- Explain the formation of emissions and its control strategies of bot SI & CI Engines.

MINORS	VEHICLE BODY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

- To make students familiar with car body details and vehicle aero dynamics
- To understand the bus body details, Commercial vehicle details, Body materials, Trim and Mechanisms

UNIT-I Car Body Details

Types: Saloon, Convertibles, Limousine, Estate Car, Racing and Sports Car. Visibility: Regulations, Driver's Visibility, Tests for Visibility, Methods of Improving Visibility and Space in Cars. Safety: Safety Design, Safety Equipment's for Cars. Car Body Construction; Design Criteria, Prototype Making, Initial Tests, Crash Tests on Full Scale Model, Dummies and Instrumentation

UNIT-II Vehicle Aerodynamics

Objectives. Vehicle Drag and Types; Various Types of Forces and Moments, Effects of Forces and Moments, Side Wind Effects on Forces and Moments, Various Body Optimization Techniques for Minimum Drag, Wind Tunnel Testing: Flow Visualization Techniques, Scale Model Testing, Component Balance to Measure Forces and Moments.

UNIT-III Bus Body Details

Types: Mini Bus, Single Decker, Double-Decker, Two Level and Articulated Bus. Bus Body Layout; Floor Height, Engine Location, Entrance and Exit Location, Seating Dimensions. Constructional Details: Frame Construction, Double Skin Construction, Types of Metal Sections used, Regulations, Conventional and Integral Type Construction.

UNIT-IV Commercial Vehicle Details

Types of Body; Flat Platform, Drop Side, Fixed Side, Tipper Body, Tanker Body, Light Commercial Vehicle Body Types. Dimensions of Driver's Seat Relation to Controls. Drivers Cab Design.

UNIT-V Body Materials, Trim and Mechanisms

Steel Sheet, Timber, Plastic, GRP, Properties of Materials; Corrosion, Anticorrosion Methods. Selection of Paint and Painting Process. Body Trim Items. Body Mechanisms

Text Books

1. James E Duffy, "Modern Automotive Technology", Goodheart-Wilcox; Seventh Edition, 2011

2. Jack Erjavec, "Automotive Technology – A systems approach", Cengage Learning, 2009,

Reference Books:

1. Geoff Davies, Materials for Automotive Bodies, Elsevier, Butterworth Heinemann, ISBN 0 7506 5692 1, 2003
2. Body Engineering , S. F. Page
3. Automotive Chassis – P.M. Heldt, Chilton & Co. 1952

Course Outcomes: After the completion of the course, the students should be able to

- Understand car body details and vehicle aero dynamics
- understand the bus body details, Commercial vehicle details, Body materials, Trim and Mechanisms

MINORS	AUTOMOBILE ELECTRICAL & ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

Course objective: To acquire the knowledge of Batteries and Accessories, Starting system, Charging system, fundamentals of automotive electronics, Sensors and actuators.

UNIT-I
Batteries and Accessories:

Principle and Construction of Lead Acid Battery, Characteristics of battery, rating capacity and Efficiency of Batteries, Various Tests on Batteries, Maintenance and Charging. Lighting System: Insulated and Earth Return System, Details of Head Light and Side Light, LED Lighting System, Head Light Dazzling and Preventive Methods – Horn, Wiper System andTrafficator.

UNIT-II
Starting System

Condition at Starting, Behavior of Starter during Starting, Series Motor and its Characteristics, Principle and Construction of Starter Motor, Working of Different Starter Drive Units, Care and Maintenances of Starter Motor, Starter Switches.

UNIT-III
Charging System

Generation of Direct Current, Shunt Generator Characteristics, Armature Reaction, Third Brush Regulation, Cutout. Voltage and Current Regulators, Compensated Voltage Regulator, Alternators Principle and Constructional Aspects and Bridge Rectifiers, New Developments.

UNIT-IV
Fundamentals of Automotive Electronics

Current Trends in Automotive Electronic Engine Management System, Electro Magnetic Interference Suppression, Electromagnetic Compatibility, Electronic Dashboard Instruments, Onboard Diagnostic System, Security and Warning System.

UNIT-V
Sensors & Actuators

Types of Sensors: Sensor for Speed, Throttle Position, Exhaust Oxygen Level, knock, Manifold Pressure, Crankshaft Position, Coolant Temperature, Exhaust Temperature, Impact sensor, Air Mass Flow for Engine Application. Solenoids, Stepper Motors, Relay.

Text Books

1. Young A.P. & Griffiths. L. “Automotive Electrical Equipment”, ELBS & NewPress-1999.
2. William B.Riddens “Understanding Automotive Electronics”, 5th edition -Butter worth Heinemann Woburn,1998.

References

1. Bechhold “Understanding Automotive Electronics”, SAE,1998.
2. Crouse, W.H “Automobile Electrical Equipment”, McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
3. Judge A.W “Modern Electrical Equipment of Automobiles”, Chapman & Hall, London,1992.
4. Kholi.P.L “Automotive Electrical Equipment”, Tata McGraw-Hill Co., Ltd., New Delhi,1975.
5. Robert Bosch “Automotive Hand Book”, SAE (5th Edition),2000.

Course Outcomes: After the completion of the course, the student should be able to acquire the knowledge of Batteries and Accessories, Starting system, Charging system, fundamentals of automotive electronics, Sensors and actuators.

MINORS	ELECTRICAL VEHICLES AND HYBRID TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives: The course should enable the students to:

- General aspects of Electric and Hybrid Vehicles (EHV), including architectures, modeling, sizing, sub-system design and hybrid vehicle control.
- Understand about vehicle dynamics,
- Design the required energy storage devices,
- Select the suitable electric propulsion systems and understand the hybrid electric vehicles.

UNIT I

INTRODUCTION

Need for hybrid and electric vehicles – main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. Case study on specification of electric and hybrid vehicles.

UNIT II

DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems.

UNIT III

ENERGY SOURCES

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery charging- Quick Charging devices. Battery Management System.

Polymer Exchange Membrane Fuel Cell- Characteristics- Half reactions of fuel cell. Cells in series and parallel- water management - Thermal Management.

UNIT IV

MOTORS

Characteristics of DC motors (Brush and Brushless), AC single phase and 3-phase motor, PM motors, Switched reluctance motors, Motor Drives and speed controllers, Torque Vectoring, Regenerative Braking. Rectifiers, Inverters, DC/AC converters.

UNIT V

SUBSYSTEMS OF HYBRID AND ELECTRIC VEHICLES

Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle- Economy of hybrid Vehicles. Choice of Tires.

TEXT BOOKS:

1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2003

2. Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005.

REFERENCES:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley &Sons,2003

2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005

3. Ron Hokinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth HeinemannPublication,2005

Course Outcomes: The students able to understand

- Electric and hybrid vehicle operation and architectures
- Design of hybrid and electric vehicles.
- Energy requirement for vehicles.
- Vehicle characteristics, operating modes, and performance parameters of the vehicle
- Different subsystems of hybrid and electric vehicles

MINORS	AUTOMOBILE POLLUTION AND ITS EFFECTS	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of different regulatory test procedures, pollutants and particulates. The student should acquire understanding about SI engine and CI engine emissions and different emission control techniques.

UNIT I

Laws and Regulation: Historical background, regulatory test procedures (European cycles). European statutory limits, Pollutants: Carbon and Nitrogen compounds-(CO.CO_2 NOx), Hydrocarbons. Volatile compounds, evaporative emissions, particulates.

UNIT-II

SI engine emissions: Mechanism & formation of HC, CO and NOx in SI engines. Engine operating variables affecting pollutants.

CI engine emissions: Mechanism & formation of HC, CO and NOx, and Soot in CI engines. Factor affecting emission formation.

UNIT-III

Emission Control Techniques in SI Engines:

Lean burn & stratified charge engines. Multipoint fuel injection and gasoline direct injection systems, exhaust gas composition, catalytic convertors, positive crank case ventilation and evaporative emission control.

UNIT-IV

Emission Control Techniques in CI Engines:

Common rail fuel injection in diesel engines. Post combustion treatments:exhaust gas recirculation, particulate traps, particulates trap regeneration,installation of catalysts in exhaust lines treatment, diesel oxidation converter.

UNIT-V

Health and environmental effects: Effects of HC, CO, NOx, SOx, CO_2 and PM emissions from SI and CI engine on living beings. Effect on environment, Acid rain formation, climate change.

TEXT BOOKS:

1. Internal Combustion Engine Fundamentals/Heywood/Mc Graw Hill
2. Internal combustion engines and air pollution/ Edward Frederic Obert/ Intext Educ. Pub
3. Bosch – Gasoline fuel injection /Bosch Publications
4. Bosch – Diesel fuel injection /Bosch Publications

5. Engine emissions – B. P. Pundir, Narosa Publishers

REFERENCES:

1. Automobiles and Pollution /PaulDegobert/ OPHRYS
2. SAE Surface Vehicle Emissions Standards Manual/ Society of Automotive Engineers
3. Automobile Pollution, Concerns, Priorities, and Challenges/ Shyam Kishor Agarwal/ APH Publishing
4. Diesel engine operation manual /V.L. Maleev/CBS Pub
5. Engine emission /Springer and Patterson/Plenum Press
6. Internal Combustion Engines /Heins Aeisth /SAE Publications.

Course outcome: The students completing this course will be in a position to derive various measures to be taken to reduce the exhaust gas pollutants coming out of automobiles to meet the laws and regulations in practice.

HONORS	NOISE, VIBRATIONS AND HARSHNESS	L	T	P	C
		3	0	0	3

Course Objectives:

- To acquire the knowledge in basic of vibration and noise
- To Understand the effect of noise an human comfort and environment
- To know the methods of vibration and noise measurement.

UNIT I
FUNDAMENTALS OF ACOUSTICS AND NOISE, VIBRATION
Theory of Sound—Predictions and Measurement, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures and Their Response to Sound, General Introduction to Vibration, Vibration of Simple Discrete and Continuous Systems, Random Vibration, Response of Systems to Shock, Passive Damping

UNIT II
EFFECTS OF NOISE, BLAST, VIBRATION, AND SHOCK
General Introduction to Noise and Vibration Effects on People and Hearing Conservation, Sleep Disturbance due to Transportation Noise Exposure, Noise-Induced Annoyance, Effects of Infrasound, Low-Frequency Noise, and Ultrasound on People, Auditory Hazards of Impulse and Impact Noise, Effects of Intense Noise on People and Hearing Loss, Effects of Vibration on People, Effects of Mechanical Shock on People, Rating Measures, Descriptors, Criteria, and Procedures for Determining Human Response to Noise.

UNIT III
VEHICLE NOISE AND VIBRATION—SOURCES, PREDICTION, AND CONTROL
Introduction to Vehicle Noise and Vibration Sources, Internal Combustion Engine Noise Prediction and Control—Diesel, Exhaust and Intake Noise and Acoustical Design of Mufflers, Tire/Road Noise—Generation, Measurement, and Abatement, Aerodynamic Sound Sources in Vehicles—Prediction and Control, Transmission and Gearbox Noise and Vibration Prediction and Control, Brake Noise Prediction and Control.

UNIT IV
VEHICLEINTERIOR NOISE AND VIBRATION SOURCES - PREDICTION AND CONTROL
Introduction to Vehicle Interior Noise and Vibration Sources, Automobile, Bus, and Truck Interior Noise and Vibration Prediction and Control, Noise and Vibration in Off-Road Vehicle Interiors-Prediction and Control,

UNIT V

NOISE AND VIBRATION TRANSDUCERS, SIGNAL PROCESSING, AND MEASURING TECHNIQUES

Introduction to Noise and Vibration Transducers, Measuring Equipment, Measurements, Signal Acquisition, and Processing, Acoustical Transducer Principles and Types of Microphones, Vibration Transducer Principles and Types of Vibration Transducers, Sound Level Meters, Noise Dosimeters, Analyzers and Signal Generators, System for Data Acquisition, Noise and Vibration Measurements, Noise and Vibration Data Analysis, Calibration of Measurement Microphones, Calibration of Shock and Vibration Transducers, Metrology and Traceability of Vibration and Shock Measurements.

TEXT BOOKS:

1. Clarence W. de Silva , "Vibration Monitoring, Testing, and Instrumentation ",CRC Press, 2007
2. David A.Bies and Colin H.Hansen "Engineering Noise Control: Theory and Practice "Spon Press, London, 2009

REFERENCES:

1. Allan G. Piersol ,Thomas L. Paez "Harris' Shock and Vibration Handbook", McGraw-Hill , New Delhi, 2010
2. Colin H Hansen "Understanding Active Noise Cancellation" , Spon Press , London 2003
3. Matthew Harrison "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles ", Elsevier Butterworth-Heinemann, Burlington, 2004

Course Outcome:

At the end of the course, the student will understand the sources, effects, prediction, control techniques, measurement techniques of noise, vibration pertain to an automobile.

HONORS	AUTOMOBILE SAFETY	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of the safety concepts, comfort and convenience system, driver assistance system and other requirements of automotive safety**.**

UNIT-I
INTRODUTION
Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction. Safety standards.

UNIT-II
SAFETY AND FATIGUE ASPECTS
Design of body, forces in roll over, head on impact, plastics collapse and analysis, fatigue and vibration, test on box sections, structural vibration.

UNIT-III
SAFETY CONCEPT
Active safety: driving safety, conditional safety, perceptibility safety, operating safety- crash safety
Passive safety: exterior safety, interior, safety, deformation behaviour of vehicle body, speed and acceleration characteristics of passenger compartment on impact.
Safety equipment: Seat belt, regulations, automatic seat belt tightened system, Anti-locking braking system(ABS), Speed limiting device(SLD)

Automatic traction control, automatic vehicle stability control, Collapsible steering system, tilt able steering system, air bags system, bumpers design for safety.

UNIT-IV
COLLISION WARNING AND AVOIDANCE
Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection, braking system interactions.

UNIT-V
COMFORT AND CONVENIENCE SYSTEM
Steering and mirror adjustment system, central locking system, tyre pressure monitoring and control system, rain sensor system, automatic climate control systems, environment information system.

TEXT BOOKS:

1. Bosch /Automotive Handbook/5th edition /SAE publication
2. Junsz Pawlowski/Vehicle Body Engineering/Business book limited, 1989.
3. Ronald K Jurgen/Navigation and Intelligent Transportation Systems-Progress in Technology/ Automotive Electronics Series, SAE. USA,1998.

Course Outcomes: After the completion of the course, the student will be able to

- Understand the design of the automobile body for safety and different safety standards
- Design the automobile body with respect to safety and fatigue aspects
- Understand active and passive safety systems
- Familiarize with different comfort and convenience systems

HONORS	SPECIAL PURPOSE VEHICLES	L	T	P	C
		3	0	0	3

Course Objectives:

- To enhance the knowledge of the students about the various equipment's used in earth moving, applications.
- To understand the construction and working of the vehicle for constructional application
- To describe the working nature of farm equipment's based on their application.
- To discriminate the various industrial vehicles based on the purpose.
- To acquire the knowledge on the functioning of military vehicle.

UNIT I
EARTH MOVING EQUIPMENTS
Construction layout, capacity and applications of dumpers, articulated haulers, front-end loaders, backhoe loaders, bulldozers, scrappers, motor graders, skid steer loaders ,excavator, hydraulic shovels, bucket conveyors , surface miners – high wall Miners. Selection criteria of prime mover for dumpers.

UNIT II
CONSTRUCTIONAL EQUIPMENTS
Construction layout, capacity and applications of cranes – types , Articulated Trucks ,concrete ready mixer, trenchers, Asphalt Pavers , road recliners, Compactors – types , draglines, drillers, borewell machine .

UNIT III
FARM EQUIPMENTS
Tractors – Main components. Working attachment of tractors – Auxiliary equipment –- Top lifting harvesters. General description, working, specification and functions paddy harvesting machines, Sugarcane harvesting, feller bunchers, forest machines.

UNIT IV
INDUSTRIAL VEHICLES
Constructional features, capacity and working of fork lifts, Utility vehicles, towing vehicles, man-lift chassis, scissor lift trucks, material handlers, recliners, Street sweepers.

UNIT V
MILITARY AND COMBAT VEHICLES
Special features and constructional details of Main Battle tank, gun carriers, transport vehicles, Armoured vehicle-launched bridge, amphibious bridging vehicle, communication vehicles.

TEXT BOOKS:

1. Abrosimov. K. Bran berg.A. andKatayer.K.“Road making Machinery ", MIR Publishers, Moscow, 1971.
2. Rodichev and G.Rodicheva, Tractor and Automobiles, MIR Publishers, 1987.
3. Wong.J.T., “Theory of Ground vehicles ", John Wiley & Sons, New York, 1987.

REFERENCES:

1. B. Geleman and M. Moskovin, Farm tractors, MIR publishers, Moscow.
2. Bart H Vanderveen, Tanks and Transport vehicles, Frederic Warne and Co ltd., London.
3. Kolchin, A., and V.Demidov, Design of Automotive Engines for Tractor, MIR Publishers, 1972.
4. Peurifoy R.L “Construction Planning, Equipment and Methods”, Tata McGraw-Hill, New Delhi, 2002.
5. Wong J “Terramechanics and Off-Road Vehicle Engineering”, Butterworth-Heinemann, 2009

Course Outcomes: After the completion of the course, the student will be able to

- Acquire the knowledge about the various equipment’s used in earth moving, applications.
- Understand the construction and working of the vehicle for constructional application
- Describe the working nature of farm equipment’s based on their application.
- Discriminate the various industrial vehicles based on the purpose.
- Acquire the knowledge on the functioning of military vehicle.

HONORS	AUTOMOBILE CERTIFICATION AND HOMOLOGATION	L	T	P	C
		3	0	0	3

Course objective: To understand the classifications of vehicles, different Vehicle Performance and Road and Track Testing procedures. Analyse the procedures for Active and Passive Safety testing and components testing.

UNIT I
Introduction
Specification & Classification of Vehicles, Regulations overview(ECE, FMVSS, AIS, CMVR, ADR), Type approval and Conformity of Production, Engine and Vehicle specifications, Two Wheeler certification.

UNIT II
Vehicle Performance Testing
Methods for evaluating vehicle performance- energy consumption (well to wheel) in conventional automobiles, performance, emission and fuel economy, Operation at full load and part load conditions, effect of vehicle condition, tyre and road condition and traffic condition and driving habits on fuel economy, Gradeability test, Turning circle diameter test, Steering Impact test, Steering effort test.

UNIT III
Road and Track Testing:
Initial inspection, PDI, engine running in and durability, intensive driving, maximum speed and acceleration, brake testing on the road, hill climbing, handling and ride characteristics, safety, mechanism of corrosion, three chamber corrosion testing, wind tunnel testing, road testing, test tracks, coast down test, Portable exhaust measurement system.

UNIT IV
Active and Passive Safety Testing:
Wheel rim testing for cornering and radial fatigue, Fire resistance test, bumper test, crash test, side impact test, rollover test, safety belt test, Airbag test, Safety belt anchorages, Seat anchorages & head restraints, Occupant protection Impact test, Side door intrusion test.

UNIT V
Components Testing:
Size and Ply rating of tyres, Safety Glasses, Wind screen wiping system, Hydraulic brake hose, Hydraulic brake fluid, Rear view mirror specification (Exterior), Rear view mirror specification (Interior), Wheel rims, Wheel nut, Wheel discs & hub caps, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints, door locks & door retention.
Overview and study of testing standards like; AIS testing standards, Euro Standards, SAE standards. ISO26262 standards for functional safety of electrical and/or electronic systems in automobiles.

TEXT BOOKS

1. Raymond M. Brach and R. Matthew Brach, "Vehicle Accident Analysis and Reconstruction Methods", SAE International, 2011
2. Automotive Industry Standards, AIS

REFERENCES

1. Ulrich Seiffert and Lothar Wech, “Automotive Safety Handbook”, SAE International, 2007
2. ISO Standards, ICS: 43.020, 43.040, 43.100

Course Outcomes: After the completion of the course, the student will be able to

- Understand the specifications and Classifications of the vehicles
- Understand the Methods for evaluating vehicle performance
- Describe the different road and track testing.
- Understand the Active and Passive Safety testing and Components testing.

HONORS	VEHICLE INFOTRONICS	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of Smart Control of Vehicle dynamics, Global Positioning systems, Driver assistance systems, Intelligent Vehicle and Adaptive control systems and other systems pertaining to Vehicle Infotronics.

UNIT-I Overview of Infotronics
Concept of Infotronics, Web-enabled Vs Web Based systems, Applications of Infotronics, Vehicle buses and protocols – LIN, CAN, MOST &Flexray.

UNIT-II Systems in vehicle
Smart control of Vehicle[ESP] dynamics, drive Electronic Throttle control by wire, active suspensions/mounting system, Automated Guided Vehicles(AGV), Multi-disciplinary optimization in Vehicles (MDO) and advanced propulsion systems(APS), Radio Communication Technologies For Vehicle Information Systems, IEEE 802.11 and DSRC.

UNIT-III Telematics
Global positioning systems, geographical information systems, navigation systems, automotive vision system, road recognition, driver assistance systems.

UNIT-IV Intelligent vehicle Control
Active and Semi active suspensions/Mounts for NVH, Optimization and stability of Hydraulic Engine mounts and Bushing in Vehicle, Rollover control and Active stability control, combined control of ride comfort in passenger cars, Active Roll over control in hydraulically actuated articulated vehicles, intelligent drive by wire vehicles, Design and realization of seer and brake by wire.

UNIT-V Adaptive Control System
Conventional control schemes, system model for adaptive control, Design of self-tuning controllers, ACC overview, system based on ACC, Stop and Go, Anti- collision system, Impact of ACC on traffic and drivers, Adaptive noise control, automatic and adaptive control of highway traffic and moving vehicles. Power steering and power window: Requirements, Introduction, characteristics.

TEXT BOOKS:
1. Intelligent Vehicle Technology by L VlACIC, M PARENT, F HARA, Butterworth-Heinemann publication.
2. Navigation and Intelligent transportation systems By Ronald K. Jurgen, SAE.

REFERENCE BOOKS:
1. Robert Bosch, Automotive Hand Book by SAE
2. Understanding Automotive Electronics by Willam B. Ribbens, SAE
3. Understanding Automotive Electronics by Bechhold, SAE.

Course Outcomes: After the completion of the course, the student will be able to

- Acquire the knowledge about Infotronics and its applications
- Understand the Smart control of Vehicle dynamics and Radio Communication Technologies for Vehicle Information Systems.
- Describe the global positioning systems and driver assistance systems.
- Understand the Intelligent Vehicle and Adaptive control systems.

HONORS	MATERIALS AND AUTOMOTIVE MANUFACTURING TECHNIQUES	L	T	P	C
		3	0	0	3

Course objective: To impart the knowledge of common engineering materials and processes with relevance to automotive applications. The student shall learn about battery materials and technology, primary and secondary processes for automotive applications and Futuristic technology and material for automotive applications.

UNIT-I

Introduction to common engineering materials; metallic and non-metallic automotive materials. Materials and processes with relevance to automotive applications. Advanced materials, light weight material, nano material and synthesis and in-situ materials for automotive applications, corrosion, Standards for automotive materials.

UNIT-II

High strength low alloy steels (HSLA), Advanced high strength steels, dual phase steels, martensitic steels, Advanced plastics and composites, Novel material for automotive applications, ultra-light weight material, Graphene - Case studies.

UNIT-III

Battery materials and technology, case studies related to automotive applications. Case studies on crank shaft, connecting rod, piston, gear and gear box, propeller shaft.

UNIT-IV

Primary and secondary processes for automotive applications – casting, forging, heavy and sheet forming, hard and soft machining, moulding, surface modification processes and Heat Treatment, Joining methods for automotive applications .Case studies on Vehicle body materials- G.I and Interstitial Free Steel processes, Power train components -Tailor Welded Blank.

UNIT-V

Futuristic technology and material for automotive applications, Designing hybrid materials-material for auto piloting, manufacturing considerations for various lightweight automotive structures , 3D printing-materials, processes and applications. Case studies on Li-ion battery, polymer composites and sensor materials.

Text Books:

1. Michel F Ashby, “Material Selection in Mechanical Design”, Butterworth Heinemann, 2007.
2. Michel F Ashby, “Material and Design: The Art and Science of Material Selection in Product Design”, Butterworth Heinemann, 2008.
3. John Mortimer, “Advanced Manufacturing in the Automotive Industry” Springer, 1997.
4. Harry Peck, “Design for Manufacturing”, Pitman Publications, 1983.
5. Cantor B, Johnston, Colin Grant and Patrick, “Automotive Engineering: Lightweight, Functional and Novel Materials”, Taylor & Francis Ltd, 2008.

Course Outcomes: After the completion of the course, the student shall acquire the knowledge of common engineering materials and processes with relevance to automotive applications. The student should be able to learn about battery materials and technology, primary and secondary processes for automotive applications and Futuristic technology and material for automotive applications.

B.TECH – IV YEAR I SEMESTER

S.No.	Category	Title	L	T	P	C
1	Professional Core	Automobile Transmission Systems	3	0	0	3
2	Management Course-II	Total Quality Management	2	0	0	2
3	Professional Elective-IV	1. Forms and Aesthetics 2. Automation using 4.0 3. EV Technology 4. Autonomous Vehicle Controls 5. Combustion Modeling 6. MOOC's/NPTEL	3	0	0	3
4	Professional Elective-V	1. Vehicle Packaging 2. Autonomous Vehicle Safety 3. Electric Vehicle Safety 4. Vehicle Aerodynamics 5. Finite Element Analysis 6. MOOC's/NPTEL	3	0	0	3
5	Open Elective – III	1. Lean Manufacturing 2. Automotive Safety 3. Introduction to Electric Vehicle	3	0	0	3
6	Open Elective-IV	1. Engine Management System 2. Introduction to TQM 3. Introduction to EV Safety 4. Quantum Science and Technology	3	0	0	3
7	Skill Enhancement Course	Vehicle Design and Analysis Lab	0	1	2	2
8	Audit Course	**Constitution of India**	2	0	0	-
9	Internship	**Evaluation of Industry Internship**	-	-	-	2
		Total	**19**	**1**	**02**	**21**

IV Year I Semester	AUTOMOBILE TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To know about the various components in transmission system and drive line units of automobiles.
2. To learn the working principle of transmission system and hydrodynamic transmission.
3. The students able to know about the various automatic transmission systems in a vehicle.
4. The students able to know the applications of automatic transmission in a vehicle.
5. To know about the hydrostatic drive principle and working of electric drive in a vehicle.

UNIT- I HYDRODYNAMIC TRANSMISSION

Fluid coupling-working principle and Constructional details, Torque capacity and Performance characteristics. Reduction of drag torque in fluid coupling. Torque converter-working principle and constructional details, performance characteristics.

UNIT-II EPICYCLIC GEARBOXES

Requirements of Epicycle gear system, Epicycle gearbox working and operation and Constructional details. Principle of Planetary gear trains - Wilson Gear box, Hydraulic Control system for Automatic Transmission.

UNIT-III AUTOMATIC TRANSMISSIONS APPLICATION

Need for automatic transmission, “Turbo glide” Transmission, Continuously Variable Transmission (CVT) – Types and of a typical CVT and applications – Tuning of CVT.

UNIT-IV HYDROSTATIC TRANSMISSION

Hydrostatic drive- various types of hydrostatic systems – Principles of Hydrostatic drive system. Advantages and limitations. Comparison of hydrostatic drive with hydrodynamic drive, construction and working of typical Janny hydrostatic drive.

UNIT V ELECTRIC DRIVE

Electric drive, layout of electric drive, types- Principle of early and modified Ward Leonard Control system-Advantages & Disadvantages, Maintenance of transmission system

TEXT BOOKS:

1. Heldt, P.M., "Torque converters", Chilton Book Co., 1962.
2. Newton and Steeds, "Motor vehicles", Illiffe Publishers, 1985.
3. Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.
4. A Text book of Auto Transmission and Electrical systems by K.S Raghu Ram.
5. Automotive Transmissions Fundamentals, Selection, Design and Application 2011. Naunheimer, H., Bertsche, B., Ryborz, J., Novak, W.

REFERENCES:

1. SAE Transactions 900550 & 930910.
2. Hydrostatic transmissions for vehicle applications, I Mech E Conference, 1981
3. Crouse, W.H., Anglin, D.L.," Automotive Transmission and Power Trains construction", McGraw-Hill, 1976.
4. Heinz Heisler, "Advance vehicle Technology", Butterworth-Heinemann, 2002

COURSE OUTCOMES:

1. Understand the concept of hydrodynamic transmissions.
2. Know about the automatic and hydrostatic transmissions and their performance.
3. Learn about the epi-cyclic gear boxes and electric drives

IV Year I Semester	TOTAL QUALITY MANAGEMENT (MANAGEMENT COURSE -II)	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

1. To understand the concepts of TQM, quality and business performance and importance of customer satisfaction and loyalty
2. To analyze organizing for quality implementation and to learn the concept of cost of quality
3. To understand ISO 9000 universal standards of quality

UNIT – I

INTRODUCTION: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II

CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – III

ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT – IV

THE COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – V

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system

TEXT BOOKS:

1. Total Quality Management / Joel E.Ross/Taylor and Francis Limited
2. Total Quality Management/P.N.Mukherjee/PHI

REFERENCES:

1. Beyond TQM / Robert L.Flood
2. Statistical Quality Control / E.L. Grant / McGraw Hill.
3. Total Quality Management- A Practical Approach/H. Lal
4. Quality Management/KanishkaBedi/Oxford University Press/2011
5. Total Engineering Quality Management/Sunil Sharma/Macmillan

COURSE OUTCOMES: At the end of the course, student will be able to

1. Understand the concepts of TQM, Quality and Business performance
2. Understand importance of customer satisfaction and loyalty
3. Summarize the concept of cost of quality
4. Understand ISO 9000 universal standards of quality

IV Year I Semester	FORMS AND AESTHETICS (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

This subject expands upon the principles and elements of design, focussing on the application of design principles to physical things and examining the interrelationships among the involved entities. The experiments involve the creation of compositions utilising rectilinear and curvilinear volumes, spatial planes, spatial curves, as well as concave and convex forms. This is significant when applied to form generating techniques inspired by a keyword or emotion.

UNIT – 1: BASIC PRINCIPLES OF DESIGN:

Point, Line & Shape, Colour, Typography**,** Space**,** Balance, Rhythm & Contrast**,** Scale**,** Grid & Alignments**,** Framing**,** Texture & Patterns**,** Visual Concept

UNIT – 2: GESTALTS PRINCIPLES

Emergence**,** Closure**,** Common Region**,** Continuity or Continuation**,** Proximity**,** Multistability**,** Figure/Ground**,** Invariance**,** Pragnanz**,** Similarity**,** Symmetry and Order**,** Common Fate

UNIT -3: TYPES OF CURVES

Fundamentals, Horizontal Curves- Simple Curve, Compound Curve, Reverse Curve Spiral Curve

Vertical Curves- Crest Curve Sag Curve, Curves in Styling -Underlying Curve, Styling Radius Curve, Beziers Curves, Transition Curves- Clothoid Spiral, Cubic Parabola.

UNIT -4: TYPES OF PLANES

Defining the Form - Principal Planes, Secondary Planes, Reflected Planes

Key aspects of Graphical Planes - Surface Continuity, Light and Shadow Character Lines

UNIT-5: RECTILINEAR AND CURVILINEAR VOLUMES

Introduction to Automotive Volumes- Visual weight, proportion, and balance, importance of 3D thinking in styling, Rectilinear Volumes- Understanding geometric forms: cube, cuboid, prism, Proportions and visual stability, Application in concept vehicles, utility vehicles, and EVs, Curvilinear Volumes -Understanding organic and fluid forms: spheres, cylinders, ellipsoids, Streamlining and aerodynamic influence, Relevance in sports cars and advanced mobility solutions, Hybrid Forms in Automotive Design - Combining rectilinear and curvilinear elements, Surface transitions and tangency, Design case studies

Visual Grammar and Aesthetics - Line, surface, and form relationships, light reflection and surface quality, Visual harmony and tension

TEXT BOOKS:

1. Elements of Design: Rowena Reed Kostellow and the Structure of Visual Relationships
2. Design Elements: Understanding the rules and knowing when to break them by Timothy Samara, Rockport Publishers

References:

1. Design Elements, Form & Space: A Graphic Style Manual for Understanding Structure and Design by Dennis Puhalla, Rockport Publishers
2. Universal Principles of Design by William Lidwell, Kritina Holden and Jill Butler, Rockport Publishers

URL:

- http://rowenafund.org/history/history-intro.html
- https://amyherlee.wordpress.com/2016/03/16/studio-mass/
- https://vanseodesign.com/web-design/dominance

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the fundamental principles of design including elements like point, line, shape, color, space, balance, and visual concept.
2. Apply Gestalt principles such as similarity, proximity, symmetry, and figure-ground to enhance visual communication and design aesthetics.
3. Identify and classify different types of curves used in styling and design, including Bezier, spiral, and transition curves.
4. Differentiate between principal, secondary, and reflected planes and analyze their impact on form, light, and surface continuity in design.
5. Analyze and create automotive volumes using rectilinear, curvilinear, and hybrid forms, considering visual weight, aerodynamics, and design aesthetics.

IV Year I Semester	AUTOMATION USING 4.0 (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

Course objectives:

- To understand the evolution of industrial revolutions and the foundational concepts of Cyber-Physical Systems (CPS) and gain knowledge of Industrial Internet of Things (IIoT) including sensor technologies, protocols, and network architectures.
- To understand digital twin technology and simulation tools for virtual commissioning and system modelling and explore the fundamentals of robotics, autonomous systems, and safety standards in collaborative industrial environments.

UNIT I

FOUNDATIONS OF INDUSTRY 4.0

Evolution: Industry 1.0 to 4.0**,** Cyber-Physical Systems (CPS) & Smart Factories**,** Reference architectures: RAMI 4.0, IIRA**,** Key drivers: connectivity, decentralization, data-driven decision making.

UNIT II

INDUSTRIAL INTERNET OF THINGS (IIOT)

Sensors & Actuators: types, interfacing, protocols (Modbus, PROFINET, OPC UA), Edge devices & gateways, Network topologies: fieldbus, Ethernet-based, wireless (Wi-Fi, BLE, LoRaWAN), MQTT & RESTful architectures.

UNIT III

DATA ACQUISITION, STORAGE & ANALYTICS

Data pipelining: SCADA, Historian systems, Time-series databases vs. relational DBs, Basics of Big Data and edge analytics, Introduction to Python/R for data cleaning & visualization, Predictive maintenance: anomaly detection, simple ML models.

UNIT IV

DIGITAL TWIN & SIMULATION

Concept of digital twin models, 3D modeling & real-time synchronization, Case studies using Simulation tools, Virtual commissioning.

UNIT V

ROBOTICS & AUTONOMOUS SYSTEMS

Collaborative robots (cobots) & AGVs/AMRs, ROS basics & sensor integration (LiDAR, vision), Path planning & task scheduling, Safety standards for human–robot interaction (ISO 10218, ISO/TS 15066).

TEXT BOOKS :

1. **Kagermann, Wahlster & Helbig** – *Recommendations for Implementing the Strategic Initiative Industrie 4.0* (acatech paper)
2. **Alessandro Bacchiega** – *IoT for Automation* (Packt Publishing)
3. **Rajkumar Buyya et al.** – *Mastering Cloud Computing* (for edge/cloud concepts)
4. **Karl Mathia et al.** – *Digital Twin Driven Smart Manufacturing* (Springer)
5. **Jürgen Jasperneite, Stefan Wartzack (eds.)** – *Cyber-Physical Production Systems*

References:

- SO/TS 15066 and ISO 10218: Official standards — available from ISO.org.
- ROS Tutorials: https://wiki.ros.org .
- Big Data Concepts: "Big Data: A Revolution That Will Transform..." – Viktor Mayer-Schönberger.
- Digital Twin Demos: Siemens NX, Dassault Systèms

Course Outcomes

At the end of the course, the student will be able to

1. Understand the evolution of Industry 4.0 and the role of cyber-physical systems, smart factories, and reference architectures like RAMI 4.0 and IIRA.
2. Explain the working of industrial IoT components such as sensors, actuators, communication protocols, and network topologies.
3. Analyze data acquisition methods and apply basic analytics using tools like Python/R for predictive maintenance and decision-making.
4. Understand the concept of digital twins and demonstrate their application through simulation tools and virtual commissioning.
5. Explore robotics and autonomous systems, including cobots, AGVs/AMRs, and ensure safety in human–robot collaboration according to ISO standards.

IV Year-I Semester	EV TECHNOLOGY (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand working of different types of electric vehicles.
2. To explain the battery parameters.
3. To understand different types of batteries.
4. To illustrate battery charging and modelling
5. To introduce novel and alternate energy sources, charging stations, levels of charging,

UNIT-I: TYPES OF ELECTRIC VEHICLE - Battery electric vehicles, Hybrid vehicle, fuelled electric vehicles, EVs using electric supply lines, Solar powered vehicles, EVs which use flywheels / super capacitors.

UNIT-II: ELECTRIC VEHICLES - BATTERY OPERATING PARAMETERS: Electrochemical Batteries, Cell and battery voltages, Charge (or Amp hour) capacity, Energy stored, Specific energy, Energy density, Specific power, Amp hour (or charge) efficiency, Energy efficiency. Self-discharge rates, Battery geometry, Battery temperature, Battery life and number of deep cycles.

UNIT-III: TYPES OF BATTERIES - Lead Acid Batteries, Nickel-based Batteries: Introduction, Nickel cadmium, Nickel metal hydride batteries, Sodium-based Batteries, Lithium Batteries, Metal Air Batteries, Introduction to Charging station Infrastructure.

UNIT-IV: ENERGY STORAGE MODELLING: Battery Modelling, the purpose of battery modelling, Battery equivalent circuit, Modelling battery capacity, Simulation a battery at a set power, Calculating the Peukert Coefficient, Approximate battery sizing.

UNIT- V: ALTERNATIVE AND NOVEL ENERGY SOURCES AND STORAGE: Introduction, Solar Photovoltaic, Wind Power, Flywheels, Ultra capacitors, Super Capacitors, Supply Rails, Fuel Cells and its classification, Hydrogen utilization in Fuel cells, Hydrogen for stationary and automotive applications, transmission and infrastructure requirements, safety and environmental impacts economics of transition to hydrogen systems –case studies.

TEXTBOOKS:

1. **Electric & Hybrid Vehicles, A.K. Babu, Khanna Publishing House**
2. **Automotive Fuel Technology-Electric, Hybrid and Fuel-Cell Vehicles: Jack Erjavec & Jeff Arias**

REFERENCES:

1. James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK, Electric Vehicle Technology Explained
2. M. Barak (Ed.), T. Dickinson, U. Falk, J.L. Sudworth, H.R. Thirsk, F.L. Tye, "Electrochemical Power Sources: Primary & Secondary Batteries", IEE Energy Series 1, A. Wheaton &Co, Exeter, 1980.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

COURSE OUTCOMES:

At the end of the course student will be able to

1. Identify various types of electric vehicles and their performance parameters.
2. Analyse the battery parameters and their variations during charge and discharge cycles.
3. List different types of batteries and analyse their performance parameters.
4. Examine the battery charging requirements and develop the complete battery model.
5. Identify novel and alternate energy sources which could be used in EVs.

IV Year I Semester	AUTONOMOUS VEHICLE CONTROL (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the fundamentals of connected and autonomous vehicle technologies, including the role of ECUs and cyber-physical systems.
- To learn about self-driving vehicle software, localization algorithms, and the integration of wireless communication with on-board vehicle networks and examine ethical considerations, public acceptance, and regulatory frameworks surrounding autonomous driving.

UNIT-1

Introduction To Connected, Automated And Intelligent Cars

Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology- Connectivity Fundamentals, Navigation and Other Applications.

Connected and Autonomous Vehicle Technology

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory.

UNIT-2

Sensor Technology

Sensor Technology for Advanced Driver Assistance Systems- Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology,

Impaired Driver Technology

Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology.

UNIT-3

Introduction to Self-Driving Vehicle Technology

Fundamentals of state-of-the-art Simultaneous Localization and Mapping (SLAM) , multi-sensor data fusion, and other Software defined Vehicles (SDV) algorithms. Robot Operating System (ROS) and Open Source Car Control (OSCC).

Wireless System Standards and Standards Organizations

Wireless Networking and Applications to Vehicle Autonomy: Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.

UNIT-4

Acceptance, Security and Ethics of Autonomous Driving

Importance of Ethics in Autonomous Driving, Opportunities and Risks Associated with Autonomous Driving, User / public Acceptance of Autonomous Driving

Regulations, Policies and Standards of Autonomous Driving

Regulatory bodies for highly automated and autonomous driving, Policies and policy making in autonomous driving.

UNIT-5

Advancement of Driver Assistance System And Vehicles

Recent Driver Assistance System Technology- Basics of Theory of Operation, Applications – Legacy and Applications. System Examples, Role of Sensor Data Fusion, Recent Driver Assistance System Technology applied in various automobile companies dealing with Non-Passenger Vehicles.

TEXT BOOKS:

1. George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, "Autonomous Vehicles Technologies, Regulations, and Societal Impacts", Elsevier Publications, 2021.
2. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies, 2019, Springer Publications.
3. Hanky Sjafrie, "Introduction to Self-Driving Vehicle Technology", 1st Edition, Published December 11, 2019 by Chapman and Hall/CRC.

REFERENCES:

1. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006
2. G. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003
3. Tom Denton, Automobile Electrical and Electronic Systems, 3rd Edition Elsevier Publications 2004

Course Outcomes

At the end of the course, the student will be able to

1. Understand the fundamentals of connected and autonomous vehicles, including automotive electronics, ECUs, and cyber-physical systems.
2. Explain various sensor technologies used in ADAS, including radar, LiDAR, sonar, and camera systems, along with driver impairment detection systems.
3. Analyze key technologies in self-driving systems such as SLAM, multi-sensor fusion, ROS, OSCC, and wireless networking integration.
4. Evaluate ethical, legal, and societal aspects of autonomous vehicles, including acceptance, policies, and regulatory standards.
5. Explore advancements in driver assistance technologies and sensor data fusion with applications in non-passenger and commercial vehicles.

IV Year-I Semester	COMBUSTION MODELING	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the fundamental principles of combustion processes and thermodynamic properties in engine systems.
- To study progressive combustion and its influence on heat transfer, friction, and overall engine performance using simulation tools.
- To model and evaluate gasoline engine behavior using one-dimensional and multi-dimensional flow models, including gas exchange and heat transfer phenomena.

UNIT-1 - INTRODUCTION TO COMBUSTION

Introduction to combustion- Heat of reaction- Measurement of URP- Measurement of HRP- Adiabatic flame temperature- Complete combustion in C/H/O/N Systems- Constant volume adiabatic combustion- Constant pressure adiabatic combustion- Calculation of adiabatic flame temperature and Isentropic changes of state

UNIT-2 - SI ENGINE SIMULATION FOR IDEAL AND ACTUAL CYCLES

Ideal Cycles in SI Engine- Actual working cycle in SI Engine- Deviation between Actual and Ideal Cycle – Problems- SI Engine Simulation with Adiabatic Combustion- SI Engine Temperature Drop Due to Fuel Vaporization- Full Throttle Operation - Efficiency Calculation- SI Engine Part-Throttle Operation- SI Engine Part-Throttle Efficiency Calculation- Super Charged Operation

UNIT-3 - PROGRESSIVE COMBUSTION

SI Engines Simulation with Progressive Combustion- SI Engines Simulation with Gas Exchange- Heat Transfer Process- Friction Calculation- Compression of Simulated Values- Validation Of The Computer Code-Engine Performance Simulation- Pressure Crank Angle Diagram- Other Engines Performance parameters

UNIT-4 - GASOLINE ENGINE SIMULATION

Thermodynamics of the gas exchange process- Flows in engine manifolds- One dimensional models- multi-dimensional models- Flow around valves and through ports- Models for scavenging in two strokes engines- Isothermal models- non-Isothermal models- Heat transfer and friction

UNIT-5 - DIESEL ENGINE SIMULATION Combustion in CI engines Single zone models- Premixed-Diffusive models- Wiebe' model- Whitehouse way model- Two zone models- Multizone models- Meguerdichian and Watson's model- Hiroyasu's model- Lyn's model- Flow chart preparation. (Need Modification – Two Units of Diesel Engine simulation)

TEXTBOOKS:

- Hiroyasu, H., "Diesel Engine Combustion and Its Modeling." SAE Technical Paper Series.
- Whitehouse and Way, "Simple combustion model for diesel engine simulation." SAE Papers.

References

- Patterson, D.J., and Henein, N.A., "Emission and Performance Characteristics of Spark Ignition Engines." SAE Transactions.
- Stone, R., "Introduction to Internal Combustion Engines." (Used in labs and modeling contexts)
- Annand, W.J.D., "Heat transfer in the cylinders of reciprocating internal combustion engines." Proc. IMechE.

Course Outcomes

At the end of the course, the student will be able to

1. Understand the fundamental concepts of combustion, including heat of reaction, adiabatic flame temperature, and combustion in various thermodynamic conditions.
2. Analyze ideal and actual SI engine cycles, simulate engine operation under different throttle conditions, and compute engine performance parameters.
3. Apply progressive combustion models in SI engine simulation, including gas exchange, heat transfer, friction, and validation of simulation results.
4. Evaluate gasoline engine thermodynamics using one-dimensional and multi-dimensional models for gas exchange, scavenging, and flow dynamics.
5. Understand and apply various diesel engine combustion models such as single zone, two-zone, and multi-zone approaches to simulate combustion and performance.

IV Year-I Semester	VEHICLE PACKAGING (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the basic concepts and importance of vehicle packaging in automotive design.
2. To learn the layout of various vehicle systems for space optimization.
3. To study ergonomic and safety requirements in vehicle interior and exterior packaging.
4. To understand legislative requirements influencing vehicle packaging.

UNIT I-INTRODUCTION TO VEHICLE PACKAGING

Definition and importance of vehicle packaging, Concept packaging vs. detailed packaging, Influence of vehicle architecture on packaging, Vehicle dimensions: Wheelbase, track width, overhangs, H-point, etc,. Classification of Hatchback, Sedan, SUV, MUV, etc.

UNIT II-OCCUPANT PACKAGING

Driver and passenger space requirements, Seating package – SAE J1100 standards**,** H-point and R-point concepts**,** Vision requirements – direct and indirect**,** Interior ergonomics – pedal reach, steering, gearshift layout**,** CAD tools for digital manikins.

UNIT III -POWERTRAIN AND DRIVELINE PACKAGING

Engine and transmission mounting concepts, FWD vs RWD layout considerations, Cooling system layout, Exhaust routing, Battery and electric drivetrain packaging in EVs.

Chassis and Suspension Packaging: Suspension geometry packaging, Steering system space and constraints, Brake system layout and master cylinder placement, Wheel arch and tire clearance considerations, Ground clearance and ramp break-over angle.

UNIT IV -SAFETY, LEGAL AND AESTHETIC CONSIDERATIONS

Crash zone and crumple zone packaging, Airbag and restraint system layout, Pedestrian safety and Euro NCAP/NCAT norms, Visibility and lighting regulations (headlamp, tail lamp packaging), NVH packaging aspects, Influence of styling and aesthetics on packaging.

UNIT V-CASE STUDIES AND INDUSTRY PRACTICE

Packaging studies of real-world vehicle segments, EV packaging comparison with IC engine vehicles, Use of CAD tools for digital packaging, Group mini-project: Layout design of a vehicle segment (e.g., compact SUV).

TEXT BOOKS:

1. SAE Standards – J1100, J941, etc.
2. Gillespie, T.D. – Fundamentals of Vehicle Dynamics, SAE
3. Rajesh Rajamani – Vehicle Dynamics and Control
4. Reimpell, J., et al. – The Automotive Chassis
5. Software manuals for CAD Packaging
6. Book on H – Point (Design Books)

References:

SAE J1100 – Motor Vehicle Dimensions Standard

- Defines H-point, R-point, seating package dimensions.
- Essential for Unit II.

SAE J941 – Driver's Eye Range for Vision Requirements

- Important for Unit II & IV (vision clearance, indirect vision tools).

SAE Paper 970582 – The H-point Machine and Seating Reference Point

- Covers ergonomics and seat positioning – helpful for manikin-based modeling.

Euro NCAP Technical Documents – Available at: https://www.euroncap.com

- Useful for Unit IV crash safety norms and pedestrian protection packaging.

Course Outcomes

At the end of the course, the student will be able to

1. Understand the fundamentals and importance of vehicle packaging, vehicle dimensions, and classification across different vehicle architectures.
2. Apply occupant packaging standards such as SAE J1100, and analyze ergonomics using digital tools for interior layout and visibility requirements.
3. Explain powertrain and driveline packaging strategies for both IC engine and electric vehicles, including cooling, exhaust, and suspension system integration.
4. Evaluate vehicle packaging from safety, regulatory, and aesthetic perspectives, incorporating crash zones, NVH, lighting, and styling constraints.
5. Analyze real-world packaging case studies and apply CAD tools in industry-relevant projects to design complete vehicle layouts.

IV Year I Semester	AUTONOMOUS VEHICLE SAFETY (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the components, levels of autonomy, and safety challenges associated with autonomous vehicles and explore perception systems and sensor safety mechanisms, including fusion, calibration, and fault handling.
- To analyze software reliability, cybersecurity risks, and safety standards applicable to autonomous vehicle systems and to assess human-machine interaction challenges and apply ethical and legal frameworks in autonomous driving contexts.

UNIT 1: INTRODUCTION TO AUTONOMOUS VEHICLES AND SAFETY PRINCIPLES

Levels of autonomy (SAE levels 0–5), Components of autonomous vehicles: perception, planning, control, Definitions of safety: functional, behavioural, passive, active, Safety challenges in autonomous systems, Overview of accidents and failures in Avs.

UNIT 2: PERCEPTION SYSTEMS AND SENSOR SAFETY

LIDAR, RADAR, Cameras, Ultrasonics: working and failure modes, Sensor fusion and redundancy, Fault detection and handling in perception, Sensor calibration and validation techniques.

Safety in Decision-Making and Control: Path planning and trajectory safety, Fail-safe vs fail-operational design, Emergency maneuvers and fallback strategies, Risk-aware motion planning, Real-time safety constraints in control systems.

UNIT 3: SOFTWARE RELIABILITY AND SYSTEM SAFETY

Functional safety (ISO 26262) and safety lifecycle, UL 4600 standard for AV safety, Redundancy, watchdogs, and runtime verification, Formal methods and software testing in safety-critical systems, Cybersecurity threats and mitigation in autonomous vehicles.

UNIT 4: HUMAN-MACHINE INTERACTION AND ETHICAL CONSIDERATIONS

Safety implications of driver hand-off in L2/L3 systems, User interface design for alerts and warnings, Human-in-the-loop simulations, Ethical frameworks (e.g., trolley problem, decision transparency), Regulatory and legal aspects of AV safety.

UNIT 5: VALIDATION, TESTING, AND SAFETY CERTIFICATION

Simulation and scenario-based testing (e.g., CARLA, PreScan), Hardware-in-the-loop (HIL) and software-in-the-loop (SIL), Real-world testing protocols (closed track and open-road), Safety assessment metrics: disengagements, accidents, response times, Certification approaches by NHTSA, Euro NCAP, and Indian authorities.

TEXTBOOKS:

1. Autonomous Driving – Maurer et al. (core textbook for AV systems)
2. Functional Safety for Road Vehicles – Hans-Leo Ross (core for safety, standards, and testing)

References

1. Maurer, M., Gerdes, J. C., Lenz, B., & Winner, H. (2016).

2. Autonomous Driving: Technical, Legal and Social Aspects. Springer.Ross, H.-L. (2021).
3. Functional Safety for Road Vehicles: New Challenges and Solutions for E-Mobility and Automated Driving. Springer.
4. Tavares, J. M. R. S. (2023). Sensor Technologies for Autonomous Vehicles: Advanced Perception and Control. Springer.

Course Outcomes

At the end of the course, the student will be able to

1. Understand the components and levels of autonomous vehicles and identify key safety challenges through real-world accident and failure analyses.
2. Analyze perception systems such as LiDAR, RADAR, and sensor fusion, and assess safety in decision-making and control through fault handling and risk-aware planning.
3. Apply software safety standards like ISO 26262 and UL 4600, and evaluate methods to ensure reliability, including runtime verification and cybersecurity mitigation.
4. Examine human-machine interaction and ethical considerations in AVs, including driver hand-off issues, user interface safety, and legal frameworks.
5. Implement validation, testing, and certification processes using simulation tools, HIL/SIL methods, and real-world protocols defined by global safety authorities.

IV Year I Semester	ELECTRIC VEHICLE SAFETY (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the potential electrical hazards in electric vehicles and learn safety practices for handling high-voltage systems and explore safety challenges associated with lithium-ion batteries, battery management, and thermal management systems.
- To examine charging safety, including infrastructure, protocols, and emergency handling procedures and to understand relevant Indian and international safety standards and regulations governing electric vehicle safety.

UNIT-1: ELECTRICAL SAFETY

Understanding Electrical Hazards: Recognizing risks associated with high voltage systems in EVs, including potential for electric shock and short circuits.

Protection Systems: Learning about safety features like fuses, circuit breakers, and isolation mechanisms designed to protect against electrical hazards.

Insulation and Grounding: Understanding the importance of proper insulation and grounding in EV circuits to prevent electrical faults.

Working with High Voltage: Safe procedures for working with high-voltage components and systems, including proper personal protective equipment (PPE).

UNIT-2: FUNCTIONAL SAFETY (ISO 26262)

Concept of Functional Safety: Understanding the principles of ISO 26262 and its application in EV design and development.

Risk Assessment: Learning how to identify and assess potential hazards in EV systems.

Safety Requirements: Understanding the process of defining safety requirements for EV components and systems.

Verification and Validation: Learning how to verify and validate the safety of EV systems and components.

UNIT-3 BATTERY SAFETY

Lithium-ion Battery Technology: Understanding the basics of lithium-ion battery technology, including their chemistry, construction, and performance characteristics.

Battery Management Systems (BMS): Learning about the role of BMS in monitoring and controlling battery performance - safety.

Thermal Management Systems (TMS): Understanding the phenomenon of thermal runaway in lithium-ion batteries methods to prevent it.

Battery Safety Testing: Types of various tests performed on batteries to assess their safety and performance.

Handling and Storage: Safe practices for handling and storing lithium-ion batteries.

UNIT-4: CHARGING SAFETY

Charging Infrastructure: Understanding different types of charging infrastructure and their safety aspects.

Charging Protocols: Learning about charging protocols and standards like Combined Charging System (CCS) and CHAdeMO.

Safe Charging Practices: Safe procedures for connecting and disconnecting charging cables, as well as monitoring the charging process.

Emergency Procedures: Knowing what to do in case of a charging-related emergency, such as a fire or power surge.

UNIT-5 REGULATIONS AND STANDARDS

Indian Standards (BIS): Familiarizing with relevant Indian standards for EV safety, such as IS 18590:2024 and IS 18606:2024.

International Standards: Familiarizing with international standards like ISO 26262 and their relevance to EV safety.

TEXTBOOKS:

1. **Guidelines for Electric Vehicle Safety J2344_202010, SAE 2020.**
2. **Electrical vehicle battery safety and compliance, 2023-01-0597, SAE 2023.**

REFERENCES:

1. **ARAI Safety standards**
2. **Robert Bosch GmbH - "Safety, Comfort and Convenience Systems"- Wiley; 3rd edition, 2007**

Course Outcomes:

At the end of the course, the student will be able to

1. Understand electrical hazards in EVs and apply safe working procedures, including insulation, grounding, and the use of protection systems.
2. Apply the principles of functional safety as per ISO 26262, including hazard analysis, risk assessment, and verification and validation of safety requirements.
3. Analyze lithium-ion battery safety through understanding of BMS, thermal management, battery testing, and proper handling and storage practices.
4. Evaluate charging infrastructure safety, including charging protocols, emergency handling, and safe charging practices.
5. Understand and apply national and international safety standards and regulations relevant to electric vehicle systems and components.

IV Year I Semester	VEHICLE AERODYNAMICS (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of fluid mechanics and its application to external and internal vehicle flows impacting performance and fuel efficiency and analyze the nature and components of aerodynamic drag and explore strategies to reduce drag in vehicle design.
- To examine vehicle shape optimization techniques and their effect on drag reduction, including case studies on modern automotive designs and to study vehicle handling dynamics under aerodynamic influences, such as side winds, and investigate related stability and noise issues.

UNIT-I

Introduction: Historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics.

UNIT-II

Aerodynamic drag of vehicles: Vehicle as a bluff body, flow field around a vehicle, drag force, types of drag force, analysis of aerodynamic drag, drag coefficients, strategies for aerodynamic development, low drag profiles.

UNIT-III

Shape optimization of Vehicles: Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners. Case studies on modern vehicles.

UNIT-IV

Vehicle handling: Forces and moments on a vehicle, lateral stability issues, methods to calculate forces and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in vehicles.

UNIT-V

Wind tunnels for automotive aerodynamics: Introduction, principle of wind tunnel, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques, equipment and transducers, on-road testing methods.

TEXT BOOKS:

1. Hucho .W.H., “Aerodynamic of Road Vehicles”, Butterworths Co., Ltd., 1997.
2. Fox W. Robert, McDonald T.Alan, Introduction to Fluid Mechanics, Fourth Edition, John Wiley & Sons, 1995.
3. Frank M. White, Fluid Mechanics, Tata McGraw-Hill, Singapore, Sixth Edition, 2008.
4. Frank M. White,Viscous Fluid Flow, Third Edition, McGraw-Hill Series of Mechanical Engineering, 2006.

5. John D.Anderson Jr, Modern Compressible Flow with Historical Perspective, McGraw-Hill, 1990.
6. Pope, "Wind Tunnel Testing", 2nd Edition, John Wiley & Sons New York, 1974.

References:

1. SAE Paper 2002-01-0531 – Aerodynamic Optimization of Passenger Vehicles
2. ISO 8855:2011 – Road Vehicles – Vehicle Dynamics and Terminology

IV Year I Semester	FINITE ELEMENT ANALYSIS (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

Course Outcomes

At the end of the course, the student will be able to

1. Understand fundamental fluid mechanics and analyze vehicle motion resistance, fuel consumption, and performance potential from an aerodynamic perspective.
2. Explain the concept of aerodynamic drag in vehicles, analyze different drag components, and evaluate strategies for drag reduction using low-drag profiles.
3. Apply shape optimization techniques to enhance aerodynamic performance, including modifications to vehicle front/rear ends and studying effects through real-world case studies.
4. Analyze vehicle handling characteristics under aerodynamic forces and moments, including lateral stability, side wind effects, and wind noise.
5. Understand the working principles and limitations of wind tunnels, and evaluate aerodynamic performance using both experimental and on-road testing methods.

COURSE OBJECTIVES:

- To understand the fundamentals of finite element method including stress-strain relations, plane stress and plane strain conditions, and variational principles and learn the formulation of bar elements and trusses, including discretization, stiffness matrix assembly, and application of boundary conditions.
- To develop finite element models for two-dimensional problems using constant strain triangles and axisymmetric formulations with higher-order isoparametric elements and to apply finite element methods to steady-state heat transfer and dynamic problems involving mass matrices and free vibration analysis.

UNIT-1 Introduction to finite element method, stress and equilibrium, strain –displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one dimensional problems.

UNIT-2 Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

Analysis of Trusses: Finite element modelling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations

UNIT-3 Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

UNIT-4 Finite element modelling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems. Higher order and

iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node diso-parametric elements and numerical integration.

UNIT-5 Steady state heat transfer analysis: one dimensional analysis of a fin.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis.

TEXTBOOKS:

1. The Finite Element Methods in Engineering /S.S.Rao/Pergamon.
2. Introduction to Finite Elements in Engineering, Second Edition/ Tirupati Reddy Chandrupatla./ Prentice-Hall.

REFERENCES:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho& Shah /Pearson publishers
2. An introduction to Finite Element Method /JNReddy/McGrawHill
3. The Finite Element Method for Engineers–Kenneth H. Huebner, Donald L. Dewhirst, DouglasE. Smith andTedG. By rom/John Wiley & sons (ASIA) PvtLtd.
4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5. Finite Element Analysis: for students & Practicing Engineers / G.Lakshmi Narasaiah

Course Outcomes

At the end of the course, the student will be able to

1. Understand the fundamentals of finite element method including stress-strain relations, variational methods, and formulation of one-dimensional problems.
2. Formulate and assemble stiffness matrices for bar elements and trusses, apply boundary conditions, and compute stresses, strains, and support reactions.
3. Analyze beam structures using Hermite beam elements and solve problems involving various loading conditions.
4. Model two-dimensional stress problems using CST and axisymmetric elements, and apply higher-order and iso-parametric elements in FEM.
5. Perform steady-state heat transfer and dynamic analysis using FEM, including formulation of mass matrices and evaluation of eigenvalues and eigenvectors.

IV Year I Semester	LEAN MANUFACTURING (OPEN ELECTIVE-III)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES: To understand the Lean and factory simulation, and comparison of Lean manufacturing. With other methods and the tools of Lean manufacturing, Value Stream mapping and best practices in Lean manufacturing.

Unit I

Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods – The 7 Wastes, their causes and the effects – An overview of Lean Principles / concepts / tools – Stockless Production.

UNIT-II

Lean Manufacturing Tools: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow – 5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems, Ford production systems

Unit- III

Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map – Building a Current State Map (principles, concepts, loops, and methodology) – Application to the factory Simulation scenario.

Unit - IV

Value Stream Mapping – **Future State:** Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completed Future State Maps – Application to factory simulation – Implementation of lean practices – Best Practices in Lean Manufacturing.

UNIT-V

TQM Tools and Techniques: The seven traditional tools of quality, new management tools, and six sigma: Concepts, methodology, applications to manufacturing, service sector including IT, Bench marking, Reason to benchmark, Bench marking process, FMEA, Stages, and Types. Quality circles, Quality Function Deployment (QFD), Taguchi quality loss function, TPM, Concepts, improvement needs, Cost of Quality, Performance measures

TEXT BOOKS:

Womack J. P., Jones D.T. and Roos D. – 'The Machine that Changed the World: the Story of Lean Production' – Simon & Schuster, New York – 1996
Liker J. K. – 'Becoming Lean' – Industrial Engineering and Management Press – 1998
Womack J. P. and Jones D. T. – 'Lean Thinking' – Simon & Schuster, USA – 1996
Rother M. and Shook J. – 'Learning to See' – The Lean Enterprise Institute, Brookline, USA – 2003

References

1. Womack, J. P., & Jones, D. T. (2003). Lean thinking: Banish waste and create wealth in your corporation. Simon & Schuster.
2. Bicheno, J., & Holweg, M. (2016). The Lean Toolbox: The Essential Guide to Lean Transformation (5th ed.). Picsie Books.
3. Besterfield, D. H. (2011). Total Quality Management (3rd ed.). Pearson Education India.
4. Rother, M., & Shook, J. (2003). Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA. Lean Enterprise Institute.
5. Ohno, T. (1988). Toyota Production System: Beyond Large-Scale Production. Productivity Press.

COURSE OUTCOMES:

After the completion of the course, the student will be able to

1. Understand the basics of Lean manufacturing and comparison with other methods of manufacturing
2. Learn the tools used in Lean Manufacturing and total predictive maintenance
3. Appreciate the value stream mapping and Application to the factory Simulation scenario.

IV Year I Semester	AUTOMOTIVE SAFETY (OPEN ELECTIVE-III)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE: To impart the knowledge of the safety concepts, comfort and convenience system, driver assistance system and other requirements of automotive safety**.**

UNIT-I

INTRODUCTION:

Design of the body for safety, energy equation, engine location, deceleration of vehicle inside passenger compartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction. Safety standards.

UNIT-II

SAFETY AND FATIGUE ASPECTS

Design of body, forces in roll over, head on impact, plastics collapse and analysis, fatigue and vibration, test on box sections, structural vibration.

UNIT-III

SAFETY SYSTEMS

Active safety: driving safety, conditional safety, perceptibility safety, operating safety- crash safety

Passive safety: exterior safety, interior, safety, deformation behaviour of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

Safety equipment: Seat belt, regulations, automatic seat belt tightened system, Anti-locking braking system (ABS), Speed limiting device (SLD)

Automatic traction control, automatic vehicle stability control, Collapsible and tiltable steering system, air bags system, bumpers design for safety, Introduction to Advanced driver assistance system (ADAS).

UNIT-IV

COLLISION WARNING AND AVOIDANCE

Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection, braking system interactions.

UNIT-V

COMFORT AND CONVENIENCE SYSTEM

Steering and mirror adjustment system, central locking system, tyre pressure monitoring and control system, rain sensor system, automatic climate control systems, environment information system.

TEXT BOOKS: (to check and incorporate)

Bosch /Automotive Handbook/5th edition /SAE publication Junsz Pawlowski/Vehicle Body Engineering/Business book limited, 1989. Ronald K Jurgen/Navigation and Intelligent Transportation Systems-Progress in Technology/ Automotive Electronics Series, SAE. USA,1998.

References

Huang, M. (2002). Vehicle crash mechanics. CRC Press.
Seiffert, U., & Wech, L. (2003). Automotive safety handbook. SAE International.
Heisler, H. (2002). Advanced vehicle technology (2nd ed.). Butterworth-Heinemann.
Bosch. (2018). Bosch automotive handbook (10th ed.). Wiley.
Pawlowski, J. (1984). Vehicle body layout and analysis. Business Books.
ISO. (2018). ISO 26262: Road vehicles – Functional safety. International Organization for Standardization.
Ministry of Road Transport & Highways. (2020). AIS-145: Automotive Industry Standard for safety features. Government of India.

COURSE OUTCOMES:

After the completion of the course, the student will be able to
Understand the design of the automobile body for safety and different safety standards
Design the automobile body with respect to safety and fatigue aspects
Understand active and passive safety systems
Familiarize with different comfort and convenience systems

IV Year I Semester	INTRODUCTION TO ELECTRIC VEHICLE (OPEN ELECTIVE-III)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the history and importance of Electic Vehicles
- To Understand drive-train topologies.
- To Classify various electrical drives
- To Classify energy storage technologies
- To Classify different energy management strategies.

UNIT-I:

INTRODUCTION TO ELECTRIC VEHICLES

History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies.

CASE STUDY

Comparison of efficiency of Conventional, Hybrid, Electric and Fuel cell Vehicles.

UNIT-II:

ELECTRIC DRIVE TRAINS

Basic concept of electric traction, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies.

UNIT-III:

ELECTRIC DRIVES & CONTROL

Electric motors used in electric vehicles, Control of Induction Motor Drive, Permanent Magnet (PM) motor Drive & ~~Switched Reluctance Motor (SRM) Drive~~.

UNIT-IV:

ENERGY STORAGE

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery energy storage, Different Types of Batteries, Super Capacitor based energy storage, Hybridization of different energy storage devices.

UNIT-V:

Fundamentals of Cooling systems/ Introduction to Battery management systems.

CASE STUDIES

Current issues in electric Vehicles, Thermal Protection of Battery.

TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2 nd Edition, 2017. (Unit-I, II)
2. Ali Emadi, “Advanced Electric Drive Vehicles (Energy, Power Electronics, and Machines)”, CRC Press, 2015. (Unit-III)
3. John G. Hayes and A. Goodarzi, “Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles”, Wiley, 2018. (Unit-IV & V)

REFERENCES:

James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley, 2 nd Edition 2012.

WEB RESOURCES:

1.https://nptel.ac.in/courses/108106170
2.https://onlinecourses.nptel.ac.in/noc22_ee53
3.https://onlinecourses.nptel.ac.in/noc21_ee112

COURSE OUTCOMES: At the end of the course, the student will be able to:

- To understand the history, significance, and environmental impact of electric vehicles in the context of modern transportation systems.
- To learn the architecture and working principles of various electric drive-train topologies and analyze their energy flow and efficiency.
- To gain knowledge of electric motors and their control strategies used in electric vehicles, including induction, PM, and SRM drives.
- To explore energy storage technologies for electric vehicles, including batteries, supercapacitors, and hybrid energy storage systems.
- To understand the fundamentals of cooling systems and battery management systems, and analyze current challenges related to thermal safety in electric vehicles.

IV Year I Semester	ENGINE MANAGEMENT SYSTEM (OPEN ELECTIVE-IV)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE: To impart the knowledge of the Spark Ignition and compression ignition engine management systems, engine diagnostics procedure, computerized electronic fuel injection systems and air flow fuel management strategies.

UNIT-I

Computerized Electronic Fuel Injection: Engine Input Sensors Coolant & Intake Temperature, Crankshaft Position, Camshaft Position, Manifold Absolute Pressure, Throttle Position, Oxygen, Air/Fuel Ratio, Knock Speed& Distance, Battery & Switches Output Devices -Relays, Injector Sequencing & Management, Ignition Operation, Idle Air Control, EGR, EVAP, Waste gate Solenoids, Torque Converter & Speed Control, Malfunction Indicator Light

UNIT-II

Speed Density/Mass Air Flow Fuel Management Strategies: Key ON Mode, Crank Mode, Open & Closed Loop, Wide-Open Throttle, Adaptive Memory Cells, Cruise &Deceleration, Wide-Open Throttle, Key OFF Mode Fuel Injection Systems -Electronic Fuel Systems, Computer Self-Diagnostic Circuits, Electronic Throttle Actuator Control Systems, Fuel Control, Fuel Supply System Control, Injection System Inspection and Maintenance.

UNIT-III

Engine Diagnostic Procedures Fuel System testing: On Board Diagnostics, Monitored & Non Monitored Circuits, Diagnostic Trouble Codes, Digital Engine Control System: Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cut off. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.

UNIT-IV

SI Engine Management: Feedback carburettor system, throttle body injection, multi-point fuel injection and direct injection systems, Layout and working of SI engine management systems like Bosch Mono- jetronic, L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control. Three-way catalytic converter, conversion efficiency versus lambda.

UNIT-V

CI Engine Management: Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems.

TEXT BOOKS:

1. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
2. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

REFERENCES:

1. Halderman, J. & Linder, J. (2012). Automotive Fuel and Emissions Control Systems (3rd Edition)Upper Saddle River, NJ: Pearson Education.
2. Halderman, J. D. (2011). Diagnosis & Troubleshooting of Automotive Electrical, Electronic, &Computer Systems (6th Edition) Upper Saddle River, NJ: Pearson Education.
3. Understanding Automotive Electronics – Bechfold SAE 1998
4. Automobile Electronics by Eric Chowanietz SAE
5. Fundamentals of Automotive Electronics - V.A.W.Hilliers - Hatchin, London
6. Automobile Electrical & Electronic Equipments (2000) Young, Griffitns - Butterworths, London.
7. Understanding Automotive Electronics, William B. Ribbens, 5th Edition, Newnes, Butterworth– Heinemann, 2001.
8. Automotive Computers & Digital Instrumentation – Robert N. Brandy, Prentice Hall, 2004
9. The Fundamentals of Electrical Systems - John Hartly - Longman Scientific & Technical, 2002.

COURSE OUTCOMES:

After the completion of the course, the student will be able to

1. Acquire the knowledge about Computerized Electronic Fuel Injection, Battery & Switches Output Devices
2. Understand the Air Flow Fuel Management Strategies and electronic fuel systems.
3. Describe the Engine Diagnostic Procedures Fuel System testing.
4. Analyze the spark ignition and compression ignition management systems.

IV Year I Semester	INTRODUCTION TO TOTAL QUALITY MANAGEMENT (OPEN ELECTIVE-IV)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the concepts of TQM, quality and business performance
2. To understand importance of customer satisfaction and loyalty
3. To analyze organizing for quality implementation
4. To learn the concept of cost of quality
5. To understand ISO 9000 universal standards of quality

UNIT – I

INTRODUCTION: Concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II

CUSTOMER FOCUS AND SATISFACTION: Importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – III

ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT – IV

COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – V

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system

TEXT BOOKS:

1. Total Quality Management / Joel E.Ross/Taylor and Francis Limited
2. Total Quality Management/P.N.Mukherjee/PH

REFERENCES:

1. Beyond TQM / Robert L.Flood
2. Statistical Quality Control / E.L. Grant / McGraw Hill.
3. Total Quality Management- A Practical Approach/H. Lal
4. Quality Management/KanishkaBedi/Oxford University Press/2011
5. Total Engineering Quality Management/Sunil Sharma/Macmillan

COURSE OUTCOMES:

At the end of the course, student will be able to

1. Understand the concepts of TQM, Quality and Business performance
2. Understand importance of customer satisfaction and loyalty
3. Summarize the concept of cost of quality
4. Understand ISO 9000 universal standards of quality

IV Year I Semester	INTRODUCTION TO ELECTRIC VECHICLE SAFETY (OPEN ELECTIVE-IV)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the electrical hazards associated with electric vehicles and the importance of safe handling of high-voltage systems through proper insulation, grounding, and protective equipment.
- To comprehend the principles of functional safety as per ISO 26262 and apply them to define, verify, and validate safety requirements in EV systems.
- To gain in-depth knowledge of lithium-ion battery safety, including battery chemistry, thermal runaway prevention, and the role of BMS and TMS.
- To understand charging safety in EVs by learning about infrastructure, standard protocols, and safe operating procedures.
- To familiarize with Indian and international EV safety standards and regulations, enabling compliance and enhancing safety in electric vehicle development and operation.

UNIT-1: ELECTRICAL SAFETY

Understanding Electrical Hazards: Recognizing risks associated with high voltage systems in EVs, including potential for electric shock and short circuits.

Insulation and Grounding: Understanding the importance of proper insulation and grounding in EV circuits to prevent electrical faults.

Working with High Voltage: Safe procedures for working with high-voltage components and systems, including proper personal protective equipment (PPE).

UNIT-2: FUNCTIONAL SAFETY (ISO 26262)

Concept of Functional Safety: Understanding the principles of ISO 26262 and its application in EV design and development.

Safety Requirements: Understanding the process of defining safety requirements for EV components and systems.

Verification and Validation: Learning how to verify and validate the safety of EV systems and components.

UNIT-3: BATTERY SAFETY

Lithium-ion Battery Technology: Understanding the basics of lithium-ion battery technology, including their chemistry, construction, and performance characteristics.

Battery Management Systems (BMS): Learning about the role of BMS in monitoring and controlling battery performance - safety.

Thermal Management Systems (TMS): Understanding the phenomenon of thermal runaway in lithium-ion batteries methods to prevent it.

UNIT-4: CHARGING SAFETY

Charging Infrastructure: Understanding different types of charging infrastructure and their safety aspects.

Charging Protocols: Learning about charging protocols and standards like Combined Charging System (CCS) and CHAdeMO.

Safe Charging Practices: Safe procedures for connecting and disconnecting charging cables, as well as monitoring the charging process.

UNIT-5: REGULATIONS AND STANDARDS

Indian Standards (BIS): Familiarizing with relevant Indian standards for EV safety such as IS 18590:2024 and IS 18606:2024.

International Standards: Familiarizing with international standards like ISO 26262 and their relevance to EV safety.

TEXTBOOKS:

- Electric Vehicle Technology Explained" – James Larminie & John Lowry
- Power Sources for Electric Vehicles" – Chris Mi, M. Abul Masrur, and David Wenzhong Gao

REFERENCES:

- ISO. (2018). ISO 26262: Road vehicles – Functional safety. International Organization for Standardization.
- BIS. (2024). IS 18590:2024 – Electric vehicles: Safety requirements for powertrain. Bureau of Indian Standards.
- BIS. (2024). IS 18606:2024 – Electric vehicles: Safety requirements for battery systems. Bureau of Indian Standards.
- Larminie, J., & Lowry, J. (2012). Electric vehicle technology explained (2nd ed.). Wiley.
- Doughty, D. H., & Roth, E. P. (2012). Battery safety and abuse tolerance – Fundamental research. Journal of Power Sources, 196(22), 10356–10360.

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Recognize electrical hazards in EVs and apply safety practices, including insulation, grounding, and use of PPE for high-voltage systems.
2. Understand the principles of functional safety based on ISO 26262 and apply them to define, verify, and validate EV safety requirements.
3. Analyze battery safety by understanding lithium-ion battery technology, BMS functions, and thermal management techniques to prevent thermal runaway.
4. Evaluate charging infrastructure and protocols, and implement safe charging procedures to ensure EV safety during charging operations.
5. Understand and apply relevant national and international EV safety standards, including BIS and ISO guidelines, to ensure compliance and best practices.

IV Year – I Semester	QUANTUM SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Prerequisites: Basic Physics, Linear Algebra, and Introduction to Modern Physics

Course Objectives:

1. To introduce fundamental concepts of quantum mechanics and its mathematical formalism.
2. To explore quantum computing and communication principles and technologies.
3. To understand the physical implementation and limitations of quantum systems.
4. To enable students to relate quantum theory to practical applications in computing, cryptography, and sensing.
5. To familiarize students with the emerging trends in quantum technologies.

Course Outcomes:

After completing this course, students will be able to:

CO1. Explain core principles of quantum mechanics and their technological implications.
CO2. Analyze quantum phenomena like superposition and entanglement.
CO3. Apply mathematical tools to model and solve quantum systems.
CO4. Demonstrate understanding of quantum algorithms and quantum circuits.
CO5. Evaluate potential applications and challenges in quantum communication and sensing.

Unit 1: Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrödinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.

Unit 2: Quantum Information Theory: Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)

Unit 3: Quantum Computing: Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phase-flip, and Shor's 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview)

Unit 4: Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)

Unit 5: Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, D-Wave, IonQ, India's NQM; Ethical concerns and future prospects

Text Books:

1. **"Quantum Computation and Quantum Information"** by Michael A. Nielsen and Isaac L. Chuang
2. **"Quantum Mechanics: Concepts and Applications"** by Nouredine Zettili

Online Learning Resources:

1. https://nptel.ac.in/courses/104104082
2. https://nptel.ac.in/courses/115104096
3. https://nptel.ac.in/courses/122106034

IV Year I Semester	VEHICLE DESIGN AND ANALYSIS LAB	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:

1. To familiarize the students to use modelling software for modelling automotive components.
2. To design chassis components with dimensions and strength requirements.
3. To learn the use of standard practices in modelling of components.
4. The use of modelling software to control the quality of the final engineered product.
5. To visualize the complete assembly of the various system.

PART-A - CHASSIS DESIGN EXPERIMENTS (At least 6 experiments)

1. Design and Analysis of frame.
2. Design and Analysis of clutch assembly
3. Design and Analysis of constant mesh gearbox.
4. Design and Analysis of Propeller shaft with universal joint.
5. Design and Analysis of rear axle.
6. Design and Analysis of steering system.
7. Design and Analysis of suspension system.
8. Design and simulation of Differential.
9. Design and simulation of Epicyclic (Gearbox).

PART-B – COMPUTATIONAL EXPERIMENTS

1. Simulation of fluid flow with specific application to
2. Manifolds,
3. After treatment devices and
4. Vehicle Aerodynamics

COURSE OUTCOMES:

1. Students will be able to visualize the automotive components with the help of modelling software.
2. Make the modifications instantly if required at the initial stage itself.
3. Demonstrate the knowledge on designing components to withstand the loads and deformations.
4. Synthesize, analyse and document the design of the various components.
5. Demonstrate the ability to use engineering techniques for developing vehicle components with Industry standards.

IV Year I Semester	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1. To Enable the student to understand the importance of constitution
2. To understand the structure of executive, legislature and judiciary
3. To understand philosophy of fundamental rights and duties
4. To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
5. To understand the central and state relation financial and administrative.

UNIT-I Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Learning outcomes: After completion of this unit student will

1. Understand the concept of Indian constitution
2. Apply the knowledge on directive principle of state policy
3. Analyze the History, features of Indian constitution
4. Evaluate Preamble Fundamental Rights and Duties

UNIT-II: Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions;

Learning outcomes: -After completion of this unit student will

1. Understand the structure of Indian government
2. Differentiate between the state and central government
3. Explain the role of President and Prime Minister
4. Know the Structure of supreme court and High court

UNIT-III: State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

Learning outcomes:-After completion of this unit student will

1. Understand the structure of state government
2. Analyze the role Governor and Chief Minister
3. Explain the role of state Secretariat
4. Differentiate between structure and functions of state secretariat

UNIT-IV: A-Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

LEARNING OUTCOMES:-After completion of this unit student will

1. Understand the local Administration
2. Compare and contrast district administration role and importance
3. Analyze the role of Myer and elected representatives of Municipalities
4. Evaluate Zilla panchayat block level organisation

UNIT-V: Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

LEARNING OUTCOMES:-After completion of this unit student will

1. Know the role of Election Commission apply knowledge
2. Contrast and compare the role of Chief Election commissioner and Commissiononerate
3. Analyze role of state election commission
4. Evaluate various commissions of viz SC/ST/OBC and women

REFERENCES:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. Subash Kashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government and Politics Hans
7. J. Raj Indian Government and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-RESOURCES:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

COURSE OUTCOMES: At the end of the semester/course, the student will be able to have a clear knowledge on the following:

1. Understand historical background of the constitution making and its importance for building a democratic India.
2. Understand the functioning of three wings of the government ie., executive, legislative and judiciary.
3. Understand the value of the fundamental rights and duties for becoming good citizen of India.
4. Analyze the decentralization of power between central, state and local self-government.
5. Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

1. Know the sources, features and principles of Indian Constitution.
2. Learn about Union Government, State government and its administration.
3. Get acquainted with Local administration and Pachayati Raj.
4. Be aware of basic concepts and developments of Human Rights.
5. Gain knowledge on roles and functioning of Election Commission.